Iron AND Steel ENGINEER

ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

1010 EMPIRE BUILDING — April, 1943 — PITTSBURGH, PA.

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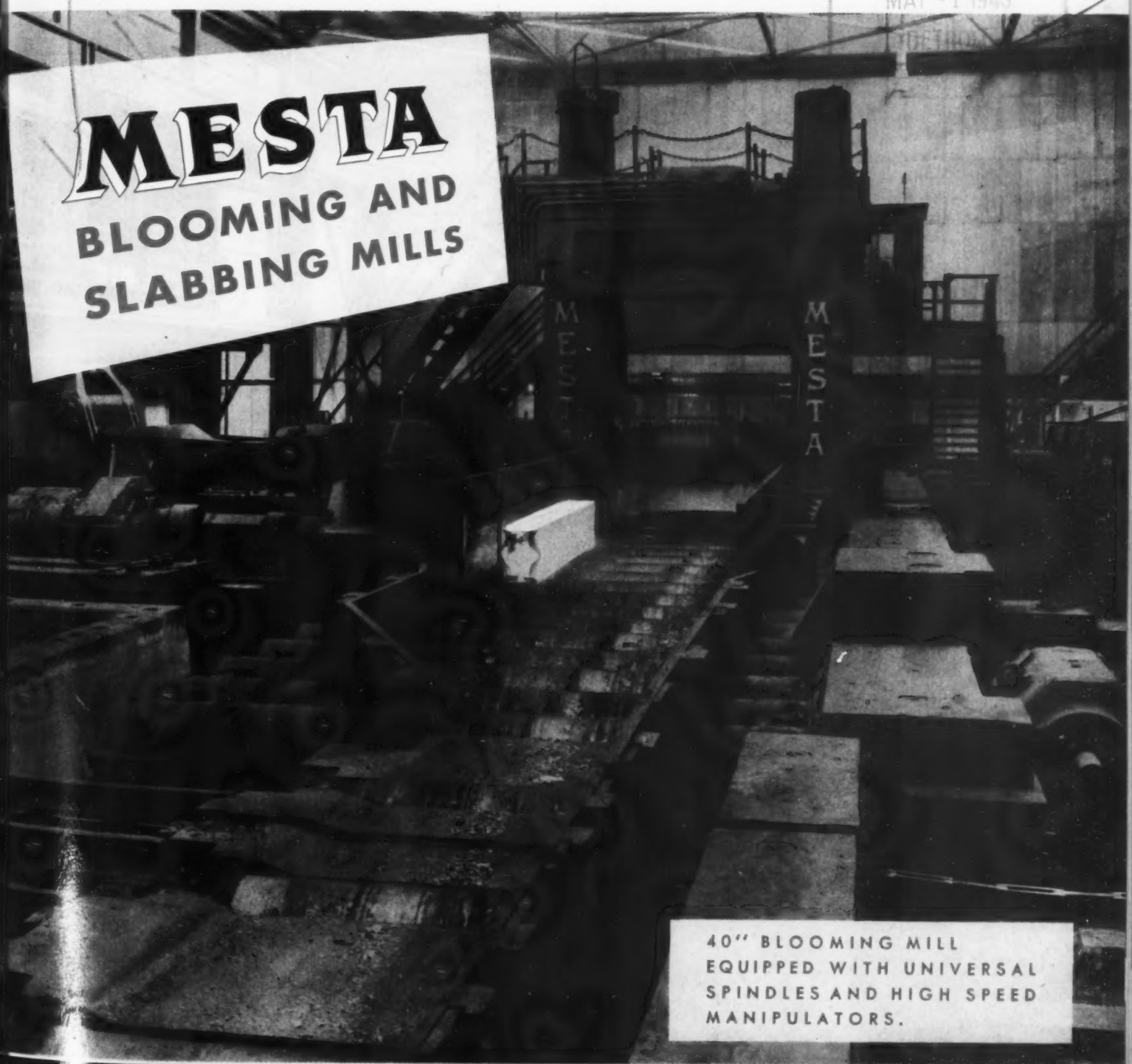
DETROIT

MESTA
BLOOMING AND
SLABBING MILLS



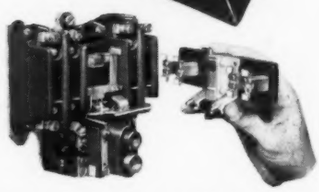
40" BLOOMING MILL
EQUIPPED WITH UNIVERSAL
SPINDLES AND HIGH SPEED
MANIPULATORS.

MESTA MACHINE CO. · PITTSBURGH, PA. ★

KEEP 'EM CLEAN TO KEEP 'EM WORKING

EVERY machine in this fight from the largest ship afloat to the smallest tool on the production front has to do its job without faltering when the time for duty arrives. And every man responsible for performance knows you have to *keep 'em clean to keep 'em working*. Dust and dirt are ever-present saboteurs that must be kept in check. What are *you* doing about motor control? Are you keeping motor control contacts clean by a strict maintenance routine . . . or are you now enjoying the extra value of having insisted upon Cutler-Hammer Motor Control with the *dust-safe* VERTICAL contacts that *shed* dirt and *keep themselves clean*? This important *basic* difference in motor control is doubly vital today when men are too scarce to waste on needless maintenance and unhalting production is imperative. When you buy motor control specify Cutler-Hammer. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER·HAMMER
MOTOR CONTROL
C·H



Cutler-Hammer Vertical Contacts
OUT IN THE OPEN—NOTHING TO HIDE
You can see the clean contacts in Cutler-Hammer Motor Control as soon as you open the case. They're out in the open where they can work cooler and last longer.

Copyright 1943, Cutler-Hammer, Inc.

SYMBOL of FREEDOM

Until a very short time ago, in the production of the imple civilization became apparent, peacetime activity to war needs Now planes, tanks, guns and quantities to all parts of the have been one of the first to

American Industry was quite inexperienced ments of war. When the danger to world the monumental task of conversion from was quickly and efficiently accomplished. munitions are flowing in unheard of world. Aetna-Standard is proud to serve its government in this capacity.

ARMY E NAVY

The AETNA-STANDARD ENGINEERING COMPANY

• YOUNGSTOWN, OHIO, U.S.A. •

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND • JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

The WEAN ENGINEERING COMPANY, Inc. • WARREN, OHIO

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

HEAVY PLATE LEVELLERS

HI-SPEED SHEET AND TIN MILL SHEAR LINES

ELECTROLYTIC & BONDERIZING TIN PLATE EQUIPMENT

WILSON TUBE ANNEALING FURNACES

WEAN VACUUM CUP SHEET AND PLATE LIFTERS

CONTINUOUS STRIP PICKLING, SLITTING, SIDE TRIMMING, AND RECOILING LINES

Associated Companies

LEE WILSON ENGINEERING CO.
CLEVELAND, OHIO

FLINN & DREFFEIN CO.
CHICAGO, ILL.

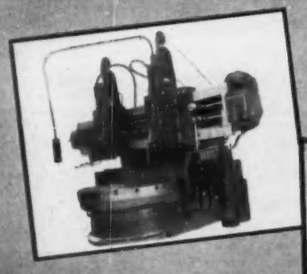
THE McKAY MACHINE CO.
YOUNGSTOWN, OHIO

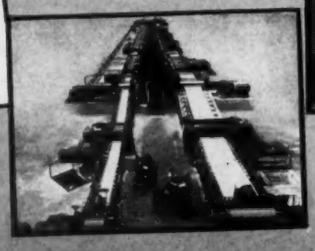
THE HALLDEN MACHINE CO
THOMASTON, CONN.

THE WELLMAN SMITH OWEN ENGR. CORP., LTD.
LONDON, ENGLAND

THE WEAN ENGINEERING CO. OF CANADA, LTD.
HAMILTON, ONT.

Subsidiary Company
THE BRODEN CONSTRUCTION CO.
CLEVELAND, OHIO

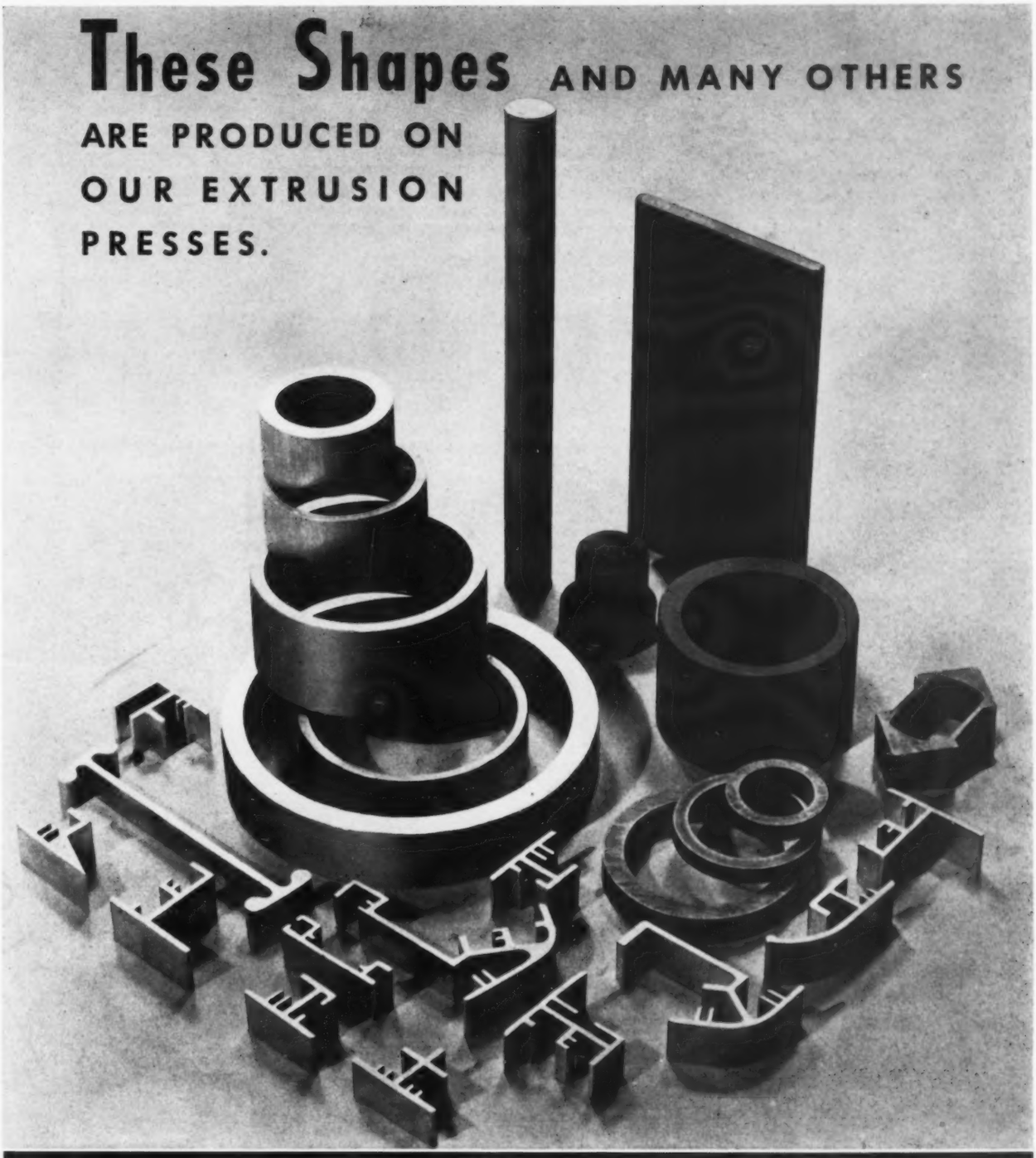




★ ★ SPECIAL MACHINERY for WAR PURPOSES ★ ★

These Shapes AND MANY OTHERS

ARE PRODUCED ON
OUR EXTRUSION
PRESSES.

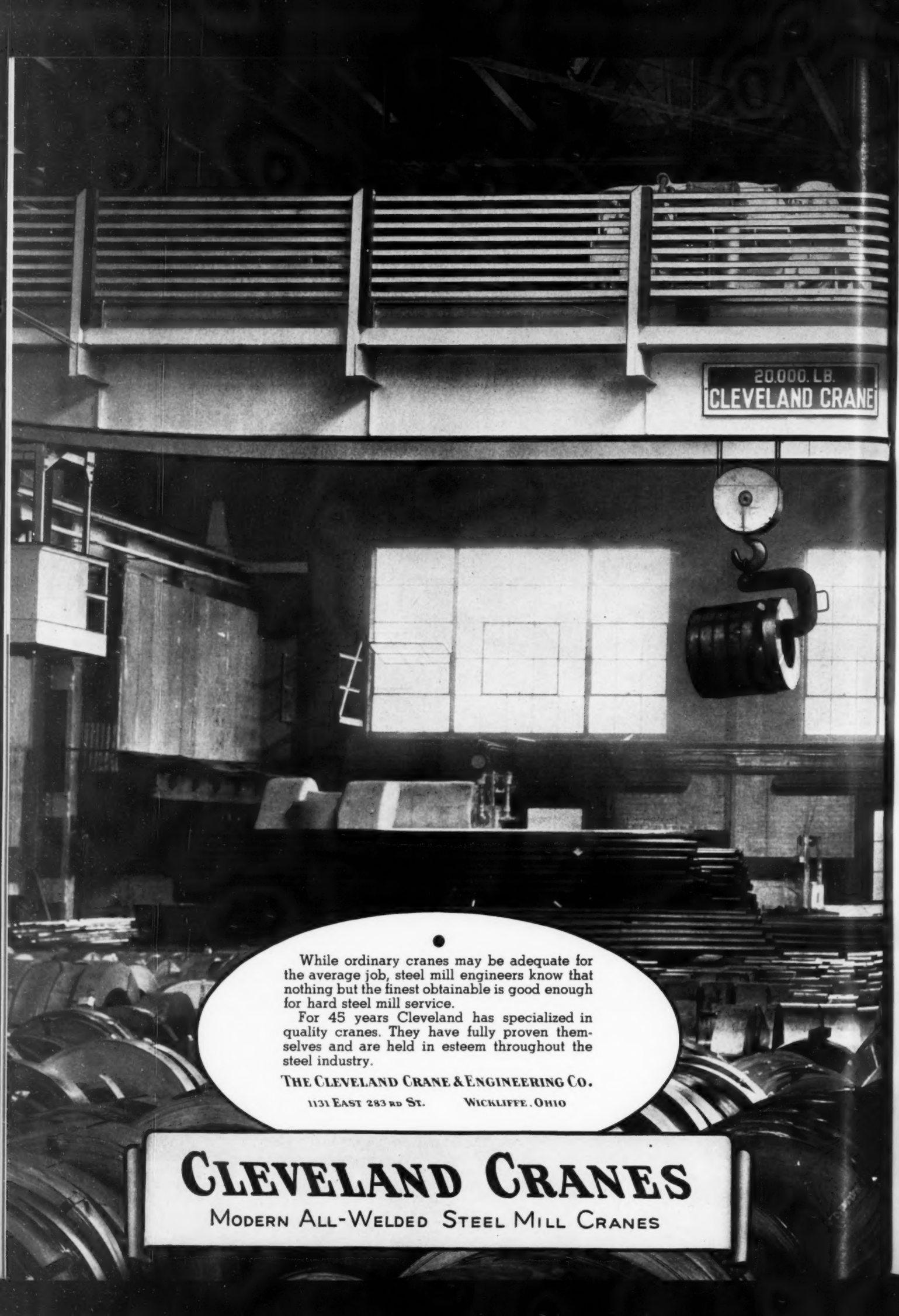


HYDROPRESS · INC.

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.



While ordinary cranes may be adequate for the average job, steel mill engineers know that nothing but the finest obtainable is good enough for hard steel mill service.

For 45 years Cleveland has specialized in quality cranes. They have fully proven themselves and are held in esteem throughout the steel industry.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

EVEN though scrap recovery drives brought us through 1942 in pretty good shape, efforts cannot be allowed to bog down. Purchased steel scrap requirements for 1943 have been set at 25,000,000 gross tons. Industrial sources are expected to yield 16,000,000 tons, with 2,500,000 tons coming from railroads and 6,500,000 tons from automobile graveyards, farms and special projects.

▲

SCATTERED over our country are a great many comparatively small manufacturers, more or less remote from industrial centers, who are doing splendid and vital production work. Being off the beaten path, and perhaps engaged in making intermediate equipment or products rather than a direct ordnance product, many of these plants have never been visited by a government representative. Some of these managements feel that a visit by an army or navy officer would give their employees a decided "lift." Surely there must be an officer or two in each ordnance district who could take a junket to these plants and administer a little "shot-in-the-arm."

▲

NOW that the flannel pajamas have been put in storage and the Victory garden season is open many will reach for a hoe instead of a No. 3 iron. Personally, we regret leaving the class that get their exercise acting as pall bearer for friends who exercised.

▲

EVERYTIME we read about absenteeism and slowdowns in industry, we can't help but think of Rudyard Kipling's phrase:
If any mourn us in the workshop, say "We died because the shift kept holiday."

▲

NOT to be outdone by the personnel departments with their upgrading of labor, the metallurgists are gradually upgrading steel. By carefully combing parts formerly requiring electric furnace steel, they have found it possible in many cases to substitute open hearth steel, the most recent case being that of bullet core wire. Likewise, bessemer steel is being substituted for open hearth steel, recommendations covering a wide field of products. It is believed that a broader application of this procedure will be decidedly beneficial to the war effort.

▲

REMEMBER when you could substitute one material for another without worrying about a substitute for the substitute?

▲

SPEAKING of substitutions, we now find that canned food rationing has repercussions in the copper industry. About 8 per cent of our production comes from the recovery of copper from copper-bearing water. Shredded cans, 100,000 tons per year, have been used for this purpose, and, what with point rationing and all, this supply is dropping, necessitating a supply of shredded light ferrous scrap from some other source.

▲

NOT recognizing the difference between a Venetian blind and a blind Venetian, there are those who are deliberately confusing the technology of our patent laws with certain dubious corporate practices, and who would meddle with our patent set-up so that the owner of a patent for an invention, even within the span of the 17 year grant, would be deprived of the full benefits of his property. It is proposed that a system of compulsory licenses should be granted — as is done in the Nazi patent law. Should the incentive to invention thus be reduced — an incentive recognized to be beneficial by all straight-thinking people and so voiced by Thomas Jefferson, Abraham Lincoln, and Franklin D. Roosevelt — America's future greatness cannot help but suffer. You may feel that you are not a patent owner or an inventor, and therefore not interested, but all of us will suffer should our patent system be destroyed. For our national welfare and our personal good, we urge that each and every reader write his Senator and Congressman recommending that:
1. For the duration, consider only such patent legislation as pertains to the war program and is limited to the war period.
2. Immediate steps should be taken to stop the malicious campaign of discouraging and harassing inventors and patent owners.
3. Immediate steps should be taken to encourage and assist inventors and patent owners in furthering inventions which might improve our war effort.
4. After the war is ended, a joint Senate-House committee should be formed to take testimony from inventors, manufacturers, scientists, engineers, etc., to ascertain what changes, if any, should be made in our patent laws.

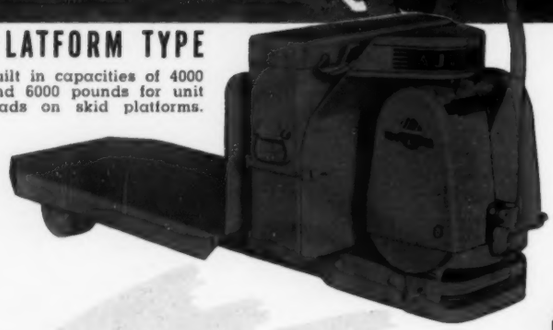
▲

IT might be nice if everyone remembered that, back of all the publicity about how fast bottoms are launched for the navy and maritime commission, there is the necessity of repairing bottoms in furnaces — also, of kicking some which are located elsewhere!

THIS MECHANIZED HANDLING SAVES WASTE IN MANPOWER AND TIME . . . .

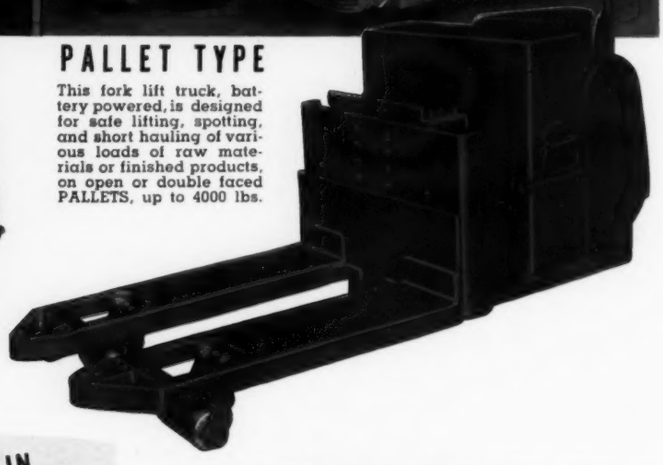
PLATFORM TYPE

Built in capacities of 4000 and 6000 pounds for unit loads on skid platforms.



PALLET TYPE

This fork lift truck, battery powered, is designed for safe lifting, spotting, and short hauling of various loads of raw materials or finished products, on open or double faced PALLETS, up to 4000 lbs.



POSITIVE MECHANICAL BRAKE

FRONT WHEEL POWER DRIVE

CONTROLS IN STEERING HANDLE

Automatic TRANSPORTER

FORWARD AND REVERSE SPEEDS

SHOCKLESS HYDRAULIC PLATFORM LIFT WITH EASY FOOT CONTROL

★ The TRANSPORTER performs a vital service in keeping materials moving on those short hauls from one process to another. This mechanized handling of small loads will simplify your entire materials haulage system whether in cramped quarters or narrow aisles . . . it speeds things up and entirely eliminates straining, tugging, pulling, or extra pushing on part of trucker.

● Full power can be attained in steering at any angle through a 210-degree range, making it easy to break out loads from storage with little maneuvering. Sufficient power is available so that no extra manual push or pull is necessary to help the truck over toe plate humps or elevator ridges.

AUTOMATIC TRANSPORTATION COMPANY

DIV. OF THE YALE & TOWNE MFG. CO.

47 W. 87TH ST. CHICAGO, ILLINOIS

MANUFACTURERS FOR OVER 25 YEARS *Electric Propelled* INDUSTRIAL LIFT TRUCKS

SEND COUPON TODAY

AUTOMATIC TRANSPORTATION CO.
47 W. 87TH ST., CHICAGO, ILL.

Gentlemen: Please furnish complete information on the "TRANSPORTER" without obligation.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

Northern SUPER-CRANES

HEAVY DUTY CRANES *for* STEEL AND METAL INDUSTRIES

Northern Crane handles all material in the storage yard of this steel mill.

Northern Crane, magnet equipped, handling heavy scrap.

Northern Crane handling a variety of materials in steel mill storage

Northern Crane in a Steel Warehouse.

Northern Cranes are working 24 hours a day — 7 days a week in hundreds of plants with no repairs and no shutdowns.

War service is extremely severe, and the pace permits no time for "coddling" a crane. They have to take it — Northern Super-Cranes do.

War pressure is particularly heavy in steel plants, and Northern Super-Cranes in that service are doing an outstanding job.

NORTHERN ENGINEERING WORKS

General Office: **2619 Atwater St., DETROIT, MICH.**

NORTHERN CRANE & HOIST WORKS, Limited • WINDSOR, CANADA

Offices at—913 South 38th St., BIRMINGHAM • 53 West Jackson Blvd., CHICAGO • 2428 Spring Grove, CINCINNATI • 5724 Navigation Blvd., HOUSTON • 44 Whitehall St., NEW YORK • 555 Union Trust Bldg., PITTSBURGH • 4135 Gratiot Ave., ST. LOUIS • 1679 University Ave., ST. PAUL

BEARINGS OR BULLETS

Today, more than ever before, man-hours are the dominating factor whether in the manufacture of bearings or bullets. Therefore, by making bearings last longer more man-hours can be applied to production of bullets—and that's important these days.

BALL BEARING LUBRIPLATE will, by virtue of its outstanding lubrication and protection features, make your ball and roller bearings last longer. LUBRIPLATE is different from any lubricant you ever used. It possesses characteristics not to be found in ordinary lubricants.

Just think what it would mean to you if you could double or treble the life of your anti-friction bearings—reduce replacement bearing and labor costs—avoid unnecessary production interruptions. That is exactly what scores of manufacturers are accomplishing with BALL BEARING LUBRIPLATE.

Your investment in ball and roller bearings is certainly great enough to warrant your investigation of BALL BEARING LUBRIPLATE. Write today for your free copy of "THE LUBRIPLATE FILM" No. 1-43 containing valuable information on the lubrication and care of ball and roller bearings.

LUBRIPLATE DIVISION
FISKE BROTHERS REFINING COMPANY
NEWARK, N. J. **SINCE 1870** TOLEDO, O.
WRITE FOR THE NAME OF THE DEALER NEAR YOU

OUR JOB

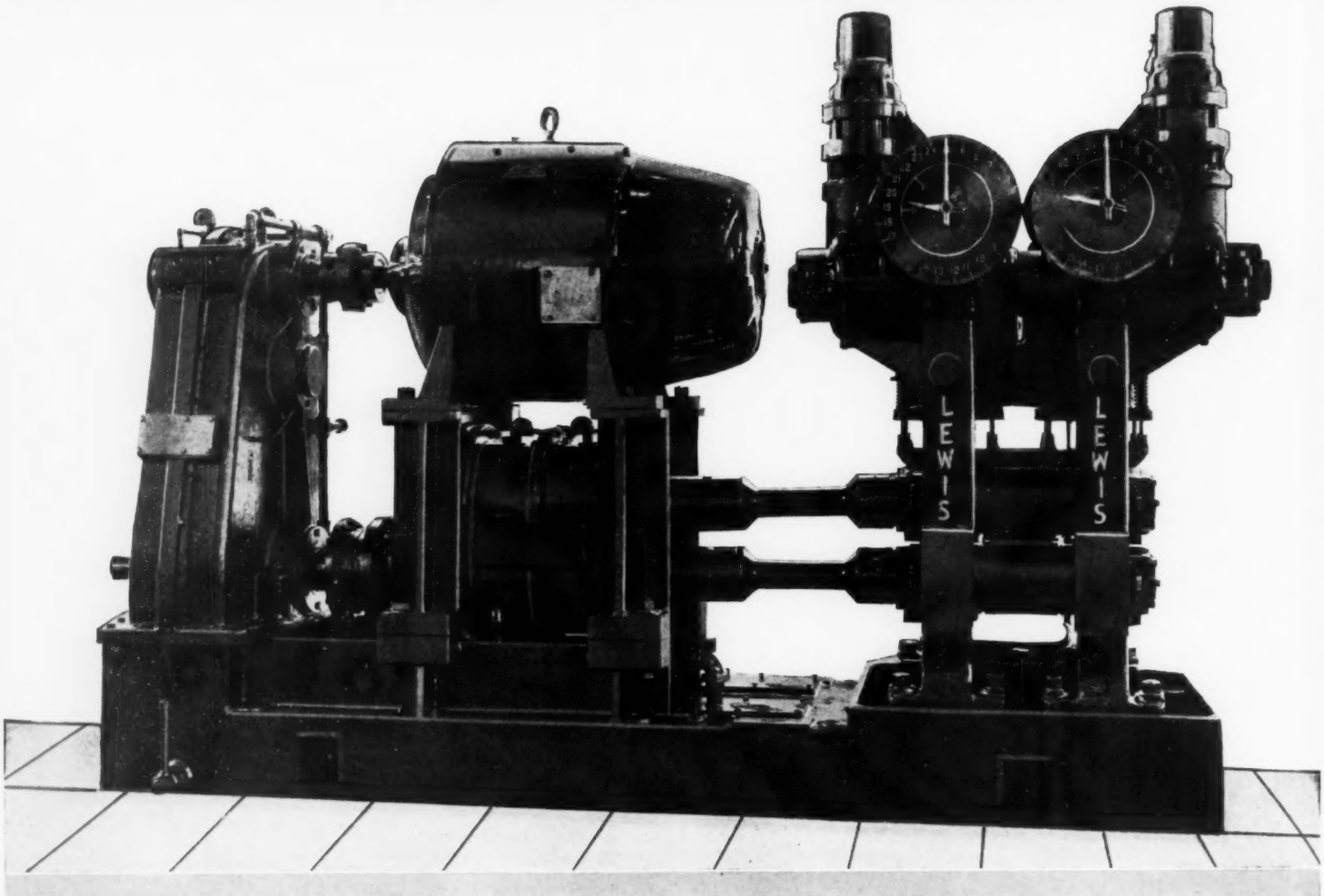
BETTER ROLLS FOR GREATER PRODUCTION

Rolling Mills depend upon Phoenix Rolls to fulfill a definite and very important part in the war program with unflagging perseverance. This confidence is indeed warranted by the performance of these rolls under unusual operating conditions.

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of
BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

THIS LEWIS MILL SAVES FLOOR SPACE



The photograph shows a good example of how Lewis has designed a sturdy Six Stand Tandem Cold Strip Mill to combine precision rolling with minimum bulk. This mill is equipped throughout with anti-friction bearings. It has universal spindles. Screwdowns are motor operated.

Lewis Rolling Mill Machinery is always abreast with the latest improvements in rolling mill practice.

LEWIS
Rolls and Rolling Mill Machinery step up tonnage

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

Forging for a landing-gear spindle, as it looks immediately after carburizing in a Micromax-controlled furnace. Heat-treatment to develop the high physicals demanded of such parts is greatly facilitated by the micro-responsiveness and dependability of the Pyrometer.

Furnaces made by Lindberg Engineering Co., and used for homogenizing, carburizing, hardening and tempering of the heat-treated parts of Army P-39 Airacobra fighting planes, are temperature-controlled by these and other Micromax Pyrometers.

WAR BIRDS HATCH UNDER MICROMAX CONTROL

In Bell's Airacobra Plant

For a department where close temperature control is an absolute "must," Bell Aircraft Corporation selected Micromax Pyrometers to control the heat-treatment of parts for the Army P-39 Airacobra. Particularly at a time when many employees are relatively inexperienced, Micromax gives a number of definite advantages:

Micro-responsive Control. Any controller of course requires that the temperature must change slightly before the instrument exerts any control action. However, in Micromax Electric (or Pneumatic) Control, this change may be so tiny that it cannot be seen on the instrument's chart, and yet the Micromax "feels" it as positively as though it were a large change. And at the same time, regardless of whether the change is big or little, Micromax throttles the fuel (or electricity) *in proportion*. It cuts heat on when a furnace door is opened, and if a new charge has been put into the furnace, Micromax keeps the heat high as the charge heats up, reducing again *in proportion* as the charge reaches the control temperature. And at control, its micro-responsiveness enables it to offset the temperature changes which are due to changes in wind or weather, furnace radiation, fuel pressure, etc., holding temperature with the steadiness required in modern fine heat-treatment.

Self-servicing Features. Micromax standardizes itself, thus eliminating the last item of daily attention. It requires chart, ink and dry batteries only at intervals of several weeks, and automatically signals for each in advance. It has a rotating telltale to show whether operating power is on or off.

The Micromax control point is set by simply turning a dial — there's no need to open the case. Strip-chart can be removed a day at a time, with no re-threading. And there are many other features, outlined in Catalog N-33A, sent on request.

Jrl Ad N-33-620(5)

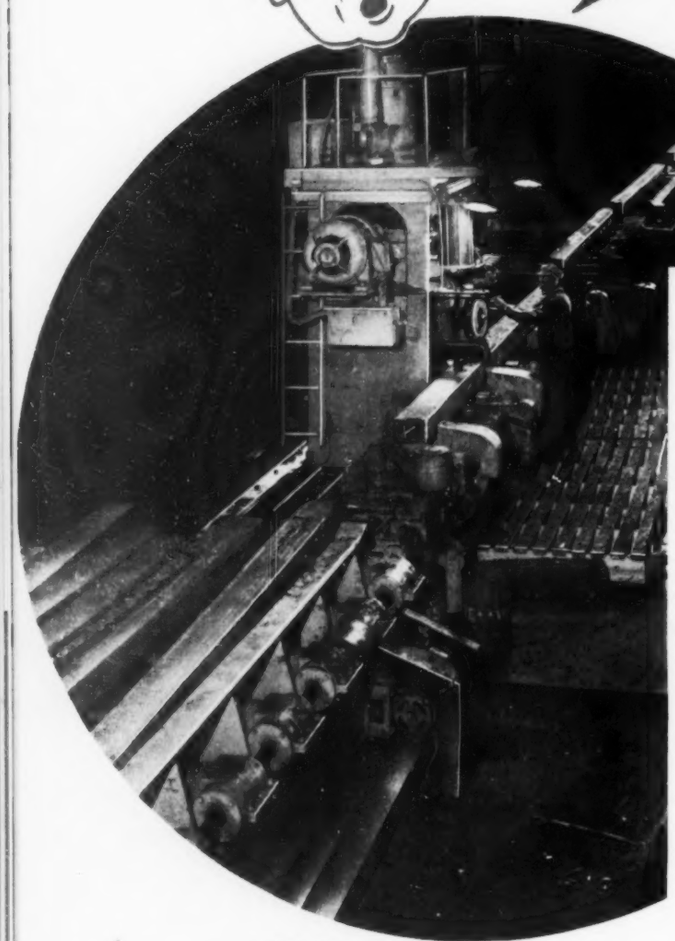
LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Yes, Adolph

THE BILLETS ARE COMING *Faster and Faster*



The doom of you and your axis is written on the billets that are turning into tanks, planes, ships, ammunition, and other fighting equipment. These billets are pouring from the cleaning departments in ever-faster tempo, because the slow and costly methods of cleaning billets by hand have been antiquated by the BILLETEER — a super production machine that chips billets 10 to 20 times faster than by hand.

How you must long, Schickelgruber, for a machine like the BILLETEER, which solves the problem of scarcity of skilled labor, lowers power demands, speeds billet production schedules tremendously, and salvages billets with defects too deep to clean profitably by hand — and does it with an average overall saving of 50%!

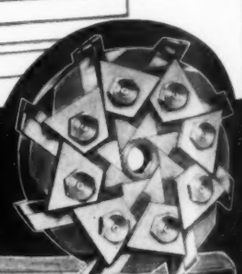
Yes, Adolph, as more and more orders are placed for BILLETEERS, more and more trouble is in the making for *you*.

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

TIMKEN BEARING EQUIPPED

BONNOT-LENTZ

BILLETEER



A MECHANIZED SUPER PRODUCTION BILLET CHIPPER

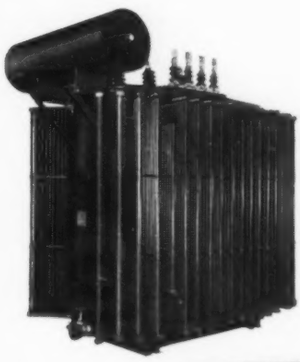
WHEN DELIVERIES ARE *Urgent* . . . HERE'S WHAT WE CAN DO

When you need transformers in a hurry — call on Pennsylvania. We are able to quote excellent deliveries on all types of transformers.

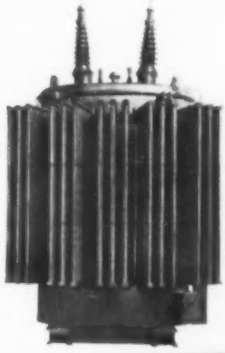
We repeat what we have said personally to many of our customers; "It is our policy never to take on more work than we can handle efficiently." This means that the quality of our transformers will not be impaired by quick deliveries.

If you have any transformer problems that need quick action — get in touch with us immediately. Make use of our ability to work quickly and get things done right.

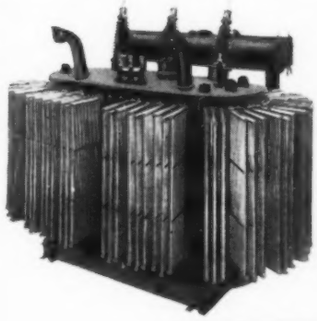
667 KVA
25 KV
21 DAYS OR BETTER



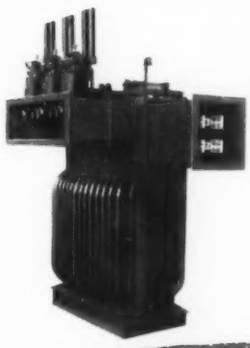
5000 KVA
34.5 KV
35 DAYS OR BETTER



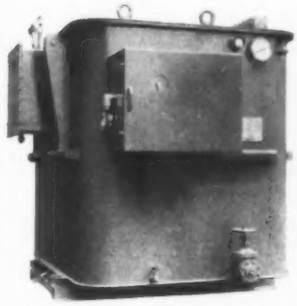
10,000 KVA
66 KV
45 DAYS OR BETTER



20,000 KVA
115 KV
55 DAYS OR BETTER



INDUSTRIAL TRANSFORMER UNIT SUBSTATION TYPE 300 KVA
21 DAYS OR BETTER



FURNACE TRANSFORMER 7500 KVA WITH MOTOR - OPERATED TAP CHANGER.
45 DAYS OR BETTER

WRITE FOR FREE COPY

of our 9 x 12, 3 color, Army & Navy Insignia Wall Placard. It includes Branch, Corps, and Division Insignia.

Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH, PENNSYLVANIA

Pennsylvania TRANSFORMERS

MORE POWER FOR *America*

All the mighty power that America wields with guns, tanks, planes, and battleships comes from millions of tiny sources. Sources of day-and-night working machines . . . of smoothly rolling shafts . . . of carefree bearings in rugged SKF Pillow Blocks that guard them by retaining lubricant and stopping the entrance of injurious material. Easy installation, inspection, and lubrication are certain with these well-designed pillow blocks. And their exclusive SKF Triple Seals block all efforts of dirt and water to reach bearings on shafts ⅝″ in diameter and up. Their presence on a machine or a lineshaft is a move toward Victory. 5261

SKF INDUSTRIES, INC., PHILADELPHIA, PA.

SKF

PILLOW BLOCKS

● SKF Pillow Block helping to build America's power on a 125 h.p., 360 r.p.m., 3-phase, 60-cycle, 208 volt unity motor built by Electric Machinery Manufacturing Corp.

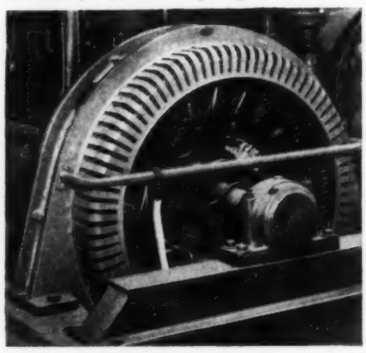
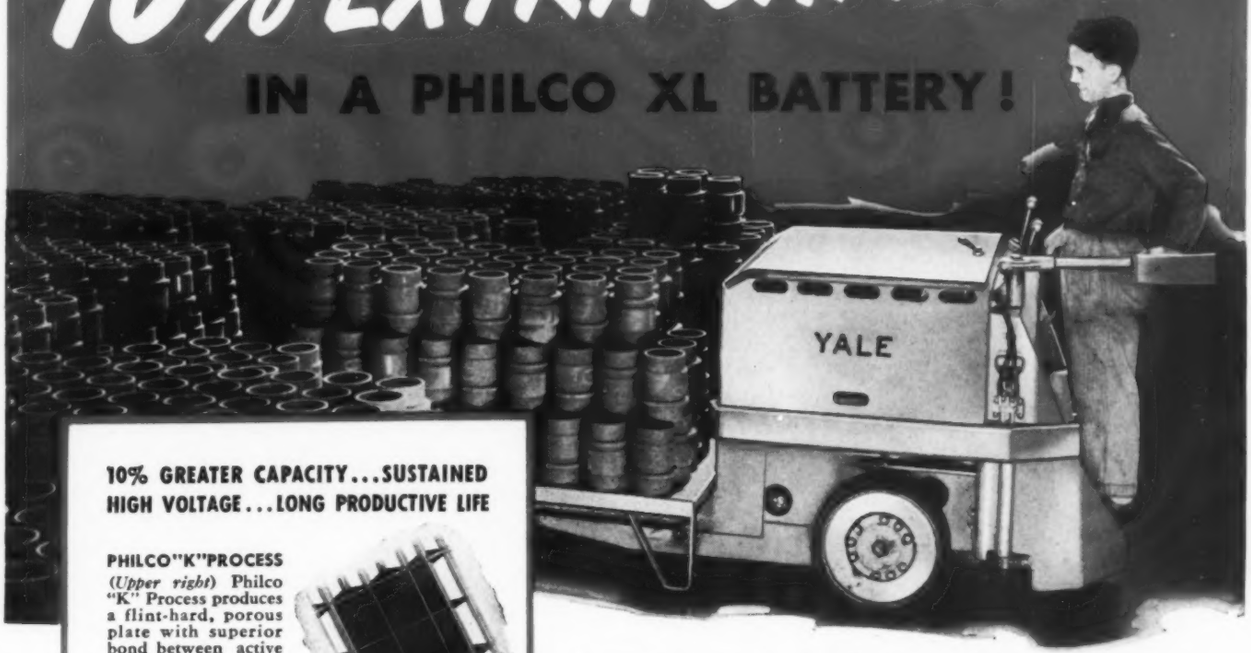


PLATE FOR PLATE, YOU GET

10% EXTRA CAPACITY

IN A PHILCO XL BATTERY!

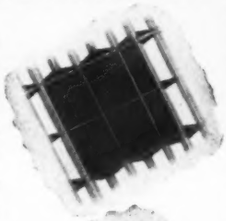


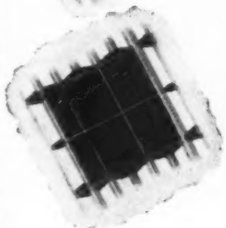
10% GREATER CAPACITY...SUSTAINED HIGH VOLTAGE...LONG PRODUCTIVE LIFE

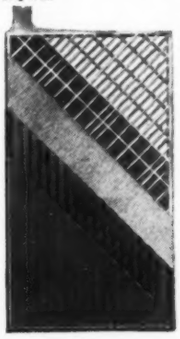
PHILCO "K" PROCESS

(*Upper right*) Philco "K" Process produces a flint-hard, porous plate with superior bond between active material and grid.

(*Lower right*) Ordinary plate drying. Active material contracts unevenly and away from grid, cracking on surface, and leaving center impervious to liquid.







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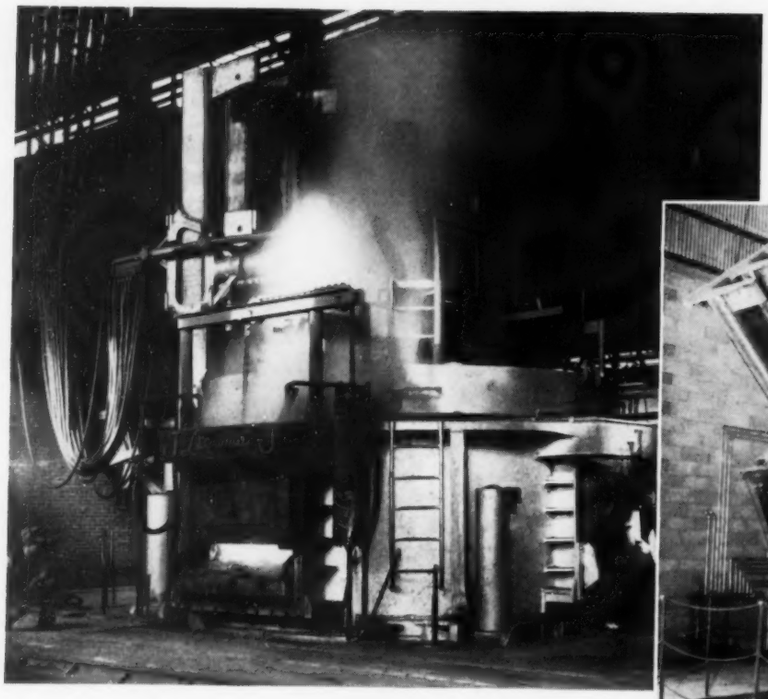

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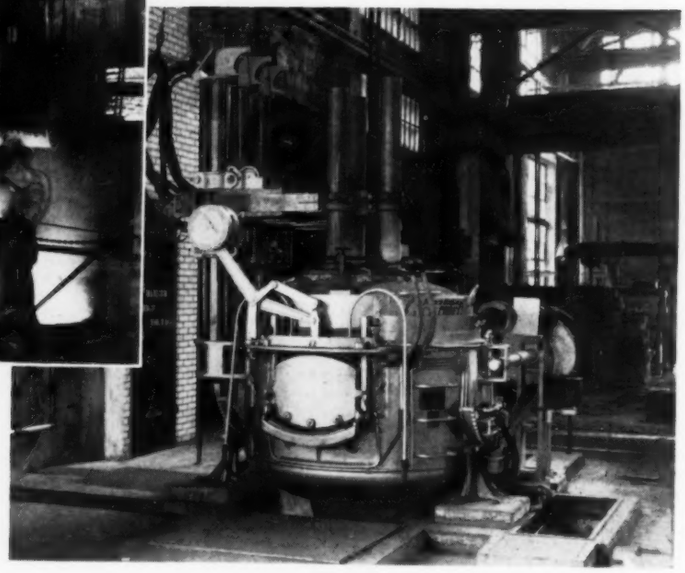

THE DEVELOPMENT *of Personnel in the Steel Industry*

. . . . the entrance of employees into the armed forces has imposed a personnel and training problem of considerable magnitude upon the iron and steel industry . . . . training courses, upgrading, female labor . . . . all these help to assure a steady flow of vitally needed steel . . . .

by Russell J. Greenly

INDUSTRIAL RELATIONS DEPT.

CARNEGIE-ILLINOIS STEEL CORP.

PITTSBURGH, PENNSYLVANIA

▲ THE development of personnel in the steel industry is not a new subject, nor is it one which is likely to be ignored in the future. It is one, however, that has become particularly urgent during the past year of war production.

I think if we face the facts courageously we will admit that very few of our efforts are directed at this time toward the development of personnel for the future, other than those which, in a natural course of events, lead to the strengthening of the supervisory or non-supervisory organization. We are concerned with the immediate; we are concerned with this month and next month and six months from today. I doubt if any of us can forecast with any reliable degree of accuracy our personnel needs two years from now.

Most of us have lost our ability to understand statistics since the war effort started. We hear that the Federal Government proposes $59,000,000,000 expenditure during the coming fiscal year. Our victory program estimates a $150,000,000,000 expenditure for war effort and all authorities concede that this is a minimum. Some estimate that it will be necessary to employ 25 million workers in the production of war materials before the war effort reaches the optimum. It is estimated that 10 million workers must be added to war industries during the current year. Perhaps no more than five or six million are engaged in the production of these materials today. We hear the arbitrary ratio of 19 production soldiers to one in the field or trench. Yes, it is difficult to understand such statistics and estimates. The data on which these estimates are made are being discarded and revised upward from day to day. Tomorrow morning's paper will probably carry an estimate which makes those suggested to you in this discussion out of date. Most of us believe that in preparing for a war effort we are assuming a 250 million population instead of 135 million.

I hope that those of you who are concerned with expansions and additions of personnel will concern yourselves primarily with the requirements of your own particular plant or department. Let the others read the statistics and shake their heads and say "It can't be done." Our job is to do this job. We know that many of our workers will be drafted into the armed forces and we can, if we open our eyes, determine rather accurately what our individual losses will be in this direction. We know that many of our skilled and semi-skilled labor will find attractive opportunities elsewhere and that labor turnover will be larger.

The first step in the planning of personnel selection and development in the steel industry is to make our best estimate of local needs, and approach the problem "What can we do about it?" This question can best be answered by surveying the sources of labor supply

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which have been taxed in the past and which we may expect to be able to tax in the immediate future. In the early months of the 1940 expansion, steel workers who had been unemployed found re-employment. This was an obvious solution to the first need for an expanding personnel. The Department of Labor estimates that practically all employable workers in the steel industry are now gainfully and productively employed.

Another source of labor supply has been the schools, which may in part be used during the war effort. It is true, however, that the armed forces recognize the advantage and need for young personnel. Exclusive of the draft many of the college graduates and students out of high school for a year or two will find their services requisitioned by the army, navy, or air corps. The drafting of technical graduates from the colleges, or the employment of those graduates in government services at relatively high beginning salaries will definitely limit industry's ability to hire capable technical graduates.

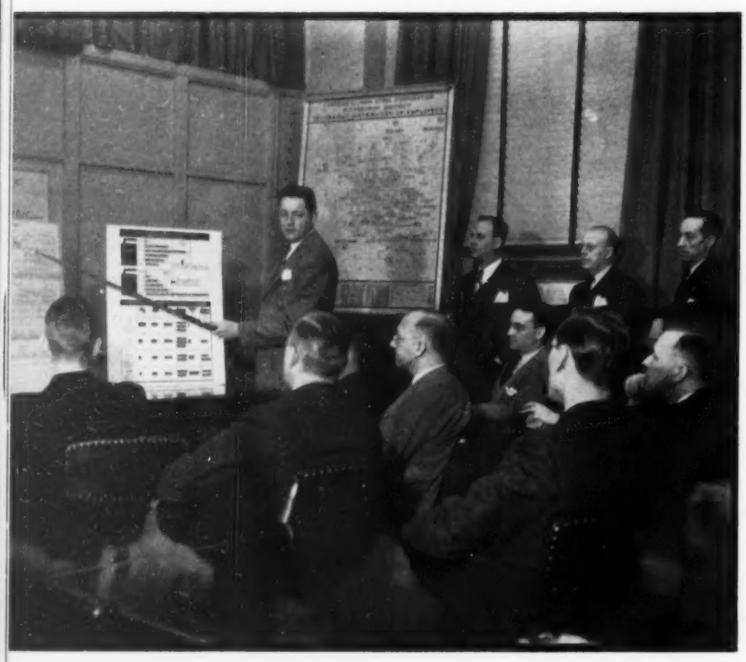

Figure 1 — Manning tables and replacement schedules aid in planning training programs to meet the growing manpower problem.

The schools are attempting to cope with the changing man-power needs through their "acceleration programs." Most of the colleges are urging students to pursue their education on a year-around basis. Many high schools are speeding up their graduation dates. Certainly this will make a larger, though younger, group available to both industry and the armed forces. As to whether industry can hope to select from these graduating groups will depend solely on our country's policy regarding the maintenance of a non-professional standing army. If that is in question, then industry will be expected to devote more serious consideration to recruitment at the other extreme of the age group. Many of us in the past have insisted that our technological or present industrial machine requires young operators. The older group will unquestionably be the last to be called upon. Retirement dates will be postponed, but I doubt seriously if those who have already stepped out of harness will be asked to return in any large numbers. In some cases where the filling of a job is an immediate necessity they unquestionably will be. In some cases these older workers may not be able to carry a complete burden in industry, but it will be possible to make a limited use of their skills. In other words these limited skills may be developed and utilized in special ways.

While the unemployed pool, the schools and young workers, the recruited workers and those workers with limited skills can all rightly be considered as possible sources of labor supply, the potentialities of these sources are not great. Without the desire to appear as an alarmist, it is safe to say that these groups cannot be relied upon to increase the production of steel to meet even the present bogies established by the national emergency.

If we are to plan intelligently the selection of new employees, we cannot afford to overlook the labor released by industries closed due to lack of material. "Priorities unemployment" is a social problem of major significance today. Not only will industry help solve the social problems of priorities unemployment by drafting these employees into their productive forces immediately, possibly in advance of actual requirements, but also we will be preparing for our own future labor shortage and provide our organization with the opportunity for training prior to actual need. Of course, in these activities we must not encourage a migratory movement of skilled workers. As, for instance, it would be the rankest sort of folly to solicit labor from the great automobile center at Detroit which is becoming one of the greatest production arsenals in the country. We can anticipate with some certainty further reductions in production of non-essential materials which will release some man-power which can and should be utilized by the steel industry. Instead of attempting to estimate the number of workers who will be available from this source, we should study carefully the possibilities of such unemployment in our own immediate districts, and through collaboration with the heads of these industries attempt to recruit men as soon as possible after their termination.

A second very important source of labor and one which is often overlooked will be found among our own employees. Every organization should untertake immediately a survey of unused skills available within the organization. Hundreds of machinists, electricians, or other skilled tradesmen are currently engaged in filling production mill positions where they can be replaced through a program of upgrading and made available on a temporary basis in the positions which require a greater length of time for development of personnel. Such shifts will often involve wage or rate problems. These must be considered, and where necessary in a program of man-power mobilization, will have to be solved. Temporary rates may be a necessity.

Upgrading in the ranks of our present employees will be a definite incentive toward more productive and superior workmanship. Promotional opportunities have long been considered an essential personnel technique

for stimulating the worker's interest in his job. Opportunities for promotion will also prevent the turnover of the superior and more ambitious employees who are within the industry. It is unfortunate that some firms who have long recognized the importance of promotional plans have done nothing to make their plans work. In the present war effort we must do more than pay lip-service to the upgrading of employees. Budgets for training must be increased. We cannot depend on the old method of training by absorption to win the production war. Individuals must be selected who are competent and assigned to the task of training others. This is the only known method of multiplying skills and the only one which can be depended upon to prepare for the future which we cannot forecast. Instead of ignoring costs as some have suggested, we must pay even greater attention to costs. The cost sheets and other indexes of performance must be fully utilized as a training medium with the supervisory organization. Intensive programs directed at the control of waste must be instituted and adhered to. We must give increased attention to costs, not for cost's sake, but as an index to productiveness. Any fair analysis of the labor supply problem leads us to the inevitable conclusion that our only possibility for meeting established goals is through increasing man-hour productivity. This can only be accomplished through well-planned training.

There remains a final source of labor supply which must be utilized to a greater degree in the steel industry. I refer, of course, to the females who are not now employed by our industrial system. Those in the steel industry who are saying that women cannot be used are blind to the necessity of the times. Their employment, it is true, must be planned with consideration of every element, but they must be used. Traditionally the steel industry has been a man's industry. Women have been used to do a certain amount of stenographic work and in some certain types of inspection, such as sorting of steel in tin plate gauges. It remains a fact, however, that we have preferred, and probably rightly so, male labor, and consequently have built up in our own minds many false concepts regarding the necessity of males in production positions. Even today one would be surprised at the result if a study of an organization were made to determine the number of male "hunt-and-peck" typists and physically able male clerical employees, many of whom should be shifted immediately to mill production. The old statement that "he is the clerical type" in a majority of cases is absurd. We are usually judging types by occupations and proficiency. It is safe to say that a majority of the clerical positions in the plants can be adequately filled by women. Actual experience has demonstrated that mill recording work, order expediting, order service, some forms of maintenance, plant protection and other similar lines of endeavor can be performed efficiently by female employees. Some forms of machine shop work can be performed effectively. There are very few types of work in this field which cannot be done by trained women if jib cranes or other mechanical equipment is available to move materials and place them in the machines. The suggestion that women could be trained to do an adequate job as crane operators, as truck drivers, or tractor operators in the steel industry may be received with a shock of disapproval. To those who consider this suggestion beyond the realm of possibility, may I refer to the United States Department of Labor's estimates that two million additional women must be employed within the next two years in industries producing war materials. During the first war more than two million women were used in such work. Of course, the majority of them were engaged in occupations where finger dexterity or manipulative skill was an essential requirement. But I fear that our efforts during the past war will pale into comparative insignificance if America is to become in reality the "arsenal for democracy." This is war. A battle between Gary and Tokio, Chicago and Milan, Pittsburgh and Hamburg.

We have considered thus far in this discussion the possible sources of labor supply both within and without our organization. We must remember, however, that a recruited labor supply is not a developed labor force. Recruitment will provide us only with the material to be developed. What can we do in developing personnel?

Figure 2 — Training classes of various kinds are working toward the development of personnel to fill up the depleted ranks of workers.

There are five basic types of training which should be discussed as possible means for developing personnel. These are as follows: trade-extension education, apprenticeship training, job training, learner training and supervisory training.

In past years many of the companies have utilized apprenticeship training with varying degrees of success. This type of training program has distinctive advantages and should not be ignored in the development of a long run training program. Apprenticeship programs, however, are time consuming and do not devote their energies to any immediate consideration of a specific job at hand. This type of training is designed to give

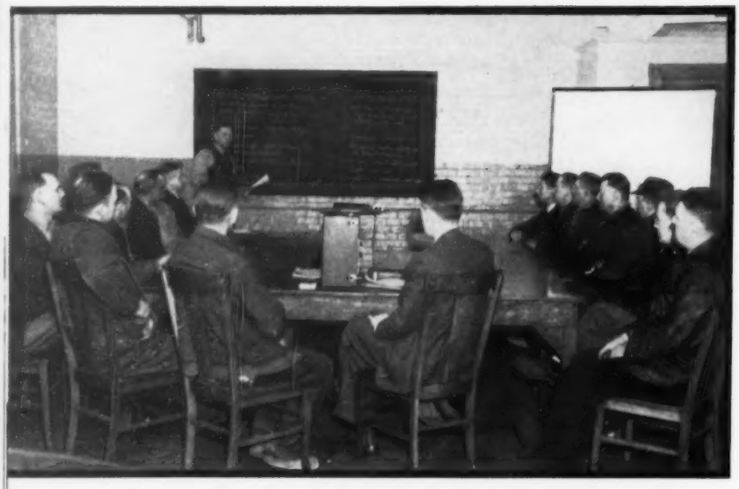

Figure 3 — Safety training has been stepped up, both as a means of educating the new employees and to further decrease the lost time arising from accidents.

the workers a general background and a fundamental knowledge which can be used as a foundation upon which the development of those workers can be made. The programs are generally designed, not to meet an immediate production problem, but to develop a skilled worker for the future. Apprenticeship is not the answer to the present training need.

During the first World War, considerable thought was given to ways and means of speeding up the training job. Jobs were often broken up into component parts and training programs were developed accordingly. In the present war effort, methods to further stream-line the training programs have been and must be developed. The problem facing training programs today is to train now — not in the future.

Job training, supervisory training and trade extension training can all lend themselves to this immediate production problem.

Training has too often been regarded as an end in itself; rather, training must be regarded as a means to an end. Training programs of the past have too often been appraised by a consideration of the time consumed. The theory was, "If it doesn't take a long time to train, the training program is inadequate." Such a criteria was based on a premise that training was the end to be accomplished. In the past, training was often carried on for the sake of training. Today the tail must not be allowed to wag the dog. Training is not an end in itself. The end, rather, must be increased production and that as quickly as possible.

The majority of our training activities should be planned on either learner training or upgrading bases. This is essential if the training of personnel is to precede the attainment of production goals.

From a functional standpoint training departments cannot be considered independent of production departments and training must not be superimposed on production. Training should not be considered a separate aspect of management. Good management, on the other hand, must include training. If training is to accomplish its production goal and do so quickly, training departments must delegate training responsibilities to those departments which might most successfully do that training. Training departments will find their place as a service organization acting in an advisory capacity to the actual training being carried on. Training will lose its identity under ideal conditions and the function of training will be executed by production management as a part of their function to promote efficient production.

Job training, supervisory training and trade extension training programs must be conceived and executed in the light of the immediately forementioned ideals or premises — that is, training is the means to an end; training is good management; and, finally, the effectiveness of the training must be measured by considering the job performance.

The question as to how a training program should be organized can only be answered after considering the particular organization undertaking such a program. In large plants the responsibility for coordinating and directing training activities should be vested in one individual. This person will be responsible for the mechanics and procedures necessary to develop the program. Production management, however, in view of the premises stated above, must accept responsibility for making the purposes and objectives of the program clear. The training, in effect, then, will become a tool of management.

A well-conceived job training program is the most effective way to bring employees to a productive level. Job training refers to an intensive short-period type of training which is designed to show the learner the best way to do a specific job. Such training, for example, might show a worker how to do a specific lathe job rather than train him to be an all-around machinist. In this period of heavy production pressure we must utilize upgrading and job training to a greater degree. In such a period of production pressure, however, conditions of production change rapidly. For best training there must be a continuous flow of information from the operating department concerned to the designated trainer. If this is not true the training program may become obsolete and not meet the immediate need at hand.

A working job training program necessitates the careful selection of a foreman or job trainer and the instruction of that individual in the technique of training learners. In order that the close contact between production management and the training department can be maintained, the job trainer should be selected from the production personnel.

The immediate goal of the job training program is to make a new worker an effective worker in the quickest possible time. This, however, should not be regarded as the only possible use of the training program. Correct job training places emphasis on progressive or promotional training. The basic idea of such a training plan is to assign the new worker to a position of sufficient simplicity and then progressively, through the continuation of the job training program, encourage that worker to proceed intelligently toward the more difficult jobs without a loss of production. In this progressive type of job training, the trainee can apply to each successive position the knowledge or skills which he

had previously learned on the job while doing actual production work. Such a well-conceived and integrated job training plan will provide a continuous source of employees for more responsible positions through continuous upgrading.

The progressive aspect of a job training program does not prevent workers progressing beyond the non-supervisory levels. In fact, progression from the non-supervisory level to the supervisory level is actually encouraged by this training procedure. The job trainers themselves should be chosen with the idea that they are of the supervisory-level calibre. The practical experience and education given the job trainer will serve as excellent training in preparing him for a more responsible supervisory position. The job training program, then, answers the second growing personnel need of the steel industry — the need for supervisory employees. This source of supervisory employees must not be overlooked by the industry.

While job training does give potential supervisors necessary training, job training in itself will not meet the complete needs for supervisory training today. More supervisors will be needed and present supervisors need training if the steel industry is to meet the demands of the war effort. Supervisory training, as distinct from job training, is the second type of training which must be used today. Supervisory training, as was the case of job training, can be utilized effectively to meet the immediate need for a developed personnel.

As is the case in correct job training programs, the staff training division must not devote its efforts to conducting the training of foremen. Rather, the training division through its director of training should serve in an advisory capacity to management and therefore must counsel management in how to train.

The conference method seems to be the best method by which supervisors can be trained. If the conference method is to be tested effectively in any plant, an educational committee or training advisory council should be established which would consist of the leading operating superintendents. The director of training should meet with this group and help develop and coordinate the program. This council will really prepare and sponsor the program. In this way training becomes an integral part of the operation and not an extra program sponsored by the training division.

In the planning of a supervisory program a determination of "What the foreman should know" must be made. Too often the programs are planned around what the person installing the program thinks the foreman should know. The judgment as to the material presented in the conference should be passed by plant management. Plant management is directly concerned and the supervisory training is to be an aspect of management. The training division should not substitute its judgment in this case although it should act in an advisory capacity.

The actual conduct of the conference method in various plants will differ depending on the size of plants and the needs in particular plants. In general, however, conference leaders for foremen group should be members of a master conference in which the same subject is presented by an authority. This may necessitate various qualified individuals of the upper supervisory levels actually conducting the master conference. This will be the method of training the conference leaders.

The conference leaders must not allow their leadership to develop into a lecture-student relationship. The function of the conference, rather, must be to develop a systematic analysis of the problem at hand. The purpose of the conference is not to tell the individual what the answer to the problem is but to develop the individual's analytical ability.

Examples and illustrations of plant problems which actually confront workers on the job should be dis-

Figures 4 and 5 — Female help has provided many of the replacements in the steel industry, and women are used in a wide variety of occupations, in some cases amounting to about 10 per cent of the total force.

cussed. This will give maximum meaning of the conference to the conference members. The various members of the conference would be expected to make individual contributions to the subject at hand and the contributions of the group as a whole would be to the benefit of individual members. The conference leader will be responsible for the constructive development of ideas presented and in some cases will see fit to present new ideas for development. The leader, however, will not assume responsibility for the development of a subject to the extent that a lecturer would.

When the conference members develop their own ideas, they not only develop their abilities to analyze complicated problems but they are more likely to use the results of their own thinking. The members can also retain the results of the conference in which they have had a definite part in the development of their results.

Not only is the conference method an excellent teaching device for supervisory workers; it is a device that has other distinctive advantages to management. In the first place, a group of foremen analyzing a particular problem represents a wealth of practical experience. Any conclusions reached will probably be sound ones and could be used advantageously by management. In such cases company policy is actually being determined at the bottom and will gravitate to the top. The conference provides an excellent point of contact between the various levels of management and permits ideas to be transmitted easily between those levels. Management must not overlook these benefits of the conference method.

The conference method will also develop "team work" in particular plants. The regularly held conference furnishes an excellent opportunity to stress the importance of team work. More important, however, is the fact that a successful conference represents the fruits of a united effort. The conference, itself, succeeds through team work. This united action can carry beyond the conference room to the productive effort at hand.

The plant manager who says, "We do not have time to carry on a program of supervisory training" may be disarming his organization of the most effective tool in increasing production — a well-trained and effective supervisor.

A final item in the importance of the conference method is the psychological benefit which comes from everyone within the organization thinking about particular problems. The conference method, in this sense, becomes a specific way by which management can stimulate interest and develop morale of the personnel. The conference method does not completely succeed if discussion is confined to the conference rooms. The benefits of the method are much larger when there is continued discussion of the problems outside of the conference. When the foremen continue discussion in the shadows of the blast furnace or behind the mill motor, then interest is stimulated. Thoughts are being developed which can be transferred into action to the benefit of concerned groups.

That job training programs and supervisory training programs are essential in the steel industry if the personnel of the industry is to be developed appears to me to be obvious. We have an immediate need for development and both of these kinds of training are adaptable to this emergency need. We must keep in mind, however, that training in itself is not the end in view. Production is the goal.

Every effort must be made to measure the effectiveness of training. Improved production records, less fuel consumption, reduction in waste, reduction in delays and many other such methods must be used to objectively measure the results of the training program. The old proverb is still true — "The proof of the pudding is in the eating." The proverb might be paraphrased and applied to training in this way — "The proof of the training is in improvements of production."

The theme of this discussion has been how the steel industry can meet its immediate need for developing its personnel. One may logically ask about the long run needs for development of personnel and whether training, again, is the logical answer to the problem — if the problem will exist at all.

I am convinced that once the premise that "training is good management" is accepted, such premise will not be rejected after the war is over. Management is recognizing the necessity for greater attention devoted to the human factor in production. Previous emphasis has too often been placed on the desirability of improving the technical aspects of production. Machine techniques have been developed and the machine themselves have been continuously improved. Men are necessary, however, in the industrial process and in the future more attention must and will be devoted to improving the efficiency of the men themselves.

More attention, of course, will be devoted to the apprenticeship and trade extension types of training. They both have their places in any long run training program. Future apprentices for instance may be selected from present learners. Thus, the transition from the immediate training program to a long run program will not be difficult.

It is certain that as long as we have turnover in the steel industry, as long as older workers leave and new workers arrive, as long as labor is not 100 per cent efficient, the personnel of the steel industry will need development. Development is a continuous problem which faces us and I am certain that one of the best ways to develop a personnel is to train it. Training is a necessity in winning the war. Training will be a necessity for the steel industry after the war is over.

DISCUSSION

PRESENTED BY

F. E. LEAHY, Superintendent Fuel Department, Youngstown Sheet and Tube Company, Campbell Works, Youngstown, Ohio

RUSSELL J. GREENLY, Industrial Relations Department, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

L. F. REINARTZ, Works Manager, American Rolling Mill Company, Middletown, Ohio

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

F. E. LEAHY: Does the Carnegie-Illinois Steel Corporation employ women in other than finishing departments?

R. J. GREENLY: We are using women in one of our plants as larryman helpers in the blast furnace department, as tractor operators, as crane operators in both operating and maintenance departments, as inspectors and stampers in armor plate departments, and some as "clean-ups." We use a great many women in our maintenance departments. We have women roll grinders in one of our roll shops. In some cases, the women can do the whole job and in other cases, women are learners and are being trained as "single-skill" operators.

As a result of a job study we have made, we have established which jobs are suitable for women in our plants. The number is surprisingly high.

F. E. LEAHY: What is the objective of your training program — is it to train specialists and "one-skill" operators?

R. J. GREENLY: That depends on the individual job. In operating a tractor, a woman does the whole job; whereas, in operating a crane, the woman is not allowed to grease the crane nor to make the minor repairs that are expected of a male craneman.

It will often be found that certain portions of the job lend themselves easily to the use of women while other parts of the same job may be too heavy for a woman to do. In this case, the training program would be set up to teach the women only that part of the job which they are physically able to do. You might term this a limited training program; for instance, we have no immediate intention of training women as all-round mechanics so we train them instead to become one-skilled operators.

In short, every position to be filled by a woman is first carefully analyzed and then the woman is trained for: first, that part of the job which she is physically able to do, and second, the part of the job which she can learn in a short period of time.

L. F. REINARTZ: Mr. Greenley has given us a very complete picture of some difficult personnel problems facing the steel industry now and in the future. I am sure each one of us could picture our own problems, and compare with him our methods for solving them. Now is no time to sit back and bemoan our shortage of labor, and the problems it has brought with it. As Managers in American Industry, particularly the strategic steel industry, we must courageously and aggressively face the situation, and bring our native intelligence, and common sense into play to overcome any obstacles, and devise new means to maintain and increase morale and war production.

Going from an abstract consideration of the entire problem, I wish to tell you briefly how, we in the Middletown Division of Armco have tried to tackle this job. We have approximately 5,000 men and women employed in our division. Since January 1st we have employed 1,089 and have lost 1,027. Over 50 per cent of these new employees are less than 21 years of age. We, therefore, have faced a serious training problem.

Training of workers and supervisors has always been an integral part of Armco policies. We believe that no matter how complete our plants, how efficient our equipment, and machinery, how excellent our processes and products may be, if we do not have energetic, interested, intelligent and trained workers as well as sympathetic, and capable management representatives we cannot make the right kind of progress in our present strenuous war effort.

Mr. C. R. Hook, president of Armco, stated many years ago, "First we must have knowledge, then comes understanding, and finally cooperation." We will all agree the key to our production problem is cooperation between management and men in a common effort. It has always been our practice, therefore, to train men and women, along general times, to know as much as possible about products and processes, management and current operating problems. This is done in several ways:

1. General — a written statement of policies.
2. The Armcooperator — a monthly employees magazine.
3. A weekly letter which is addressed to each employee every pay day. In this letter we try to inform our employees as to management problems, new installations, new equipment, and new processes. We also talk about quality, production and safety problems. We give credit for departmental and personal records and suggestions. In fact, everything we think will be of interest to employees is included in this letter.

Although such a weekly letter can become a "chore," we realize it is the best medium for dissemination of information to workmen we have ever had.

From time to time, in recent years, we have carried on superintendents and general foremen training conferences, which are conducted on a lecture and conference basis. These conferences have, at times, been jokingly called "charm schools." I can say if supervisors can use some charm in connection with their instruction and training work, the conferences will be worth while. We have passed the day when, in industry, orders must or can be given in an arbitrary manner.

Years ago a regular training program was instituted in our division. The supervisor of our Industrial Betterment Department was chosen as training supervisor on a full time assignment. Class rooms were provided at the entrance to the plant, and in various departments, to make class work as convenient for turn workers as possible. For a number of years we have enrolled from 1,100 to 1,300 different individuals in these classes each year. These studies range from blue print reading, mathematics, chemistry, metallurgy, fuel economy, to job study and operating discussion classes as well as many other subjects. Such classes are led by responsible operating and staff supervisors, and have shown practical results. In addition, seeing the handwriting on the wall, several years ago a responsible maintenance engineer was appointed as an apprentice supervisor, to train apprentices in welding, electric, machine shop work, forge and rigger work, masonry and foundry practice.

Since then the apprentices have been very carefully selected by a committee consisting of supervisors of the employment, maintenance, and training departments in consultation with a management representative. Those apprentices who have graduated from these courses have been a "god send" to us in these hectic war days. We have lost some of these young men in the draft so we are planning to try to train middle aged men from various parts of our plant which have been "hit" by the change in war schedules. Later even women may be tried out.

Lack of cranemen recently became very acute. A

middle aged skilled craneman, who had teaching ability, was selected to train new men. He spends all his time training these men. Many superintendents, in departments which have been subjected to drastic changes in processes, equipment, and practices, have instituted classes for their old and new workers, in order to improve quality and increase production.

An electric alloy steel melting shop, containing four electric furnaces, was started in June. An intensive training course was started for the operators and chemists so that they were ready to handle their responsibilities when the plant started. In less than ten days the department was put on a 100 per cent propeller alloy steel production schedule. Most of the trainees had not seen an electric melting furnace six months previous to the starting date.

A critical situation is being faced due to the drying up of our local labor supply because of the draft, high rate of employment in local industries and lure of high wages in other war industries in Cincinnati, Hamilton and Dayton, despite the fact that our labor rates are among the highest in the steel industry. We have not generally gone to a six-day week, and in such continuous seven day operations as the coke ovens, blast furnace, and open hearth departments are still on a 5-day a week basis. It has, therefore, become imperative to look for a new supply of labor. Women must fill this requirement. Already, as young clerical men have left our employ, we have replaced them with women. In offices, the rest room problem is not a serious one. Women are doing a good job in these new assignments.

When the employment of women in the shops of a heavy industry such as the steel business, is contemplated many preliminary plans must be made. A capable, reliable middle aged intelligent and sympathetic woman supervisor and advisor should first be employed. Every job in the plant must then be surveyed to see if women could be adapted to do it. The engineering department must, also, design proper rest rooms to be installed in various parts of the plant. Superintendents and supervisors must be "sold" on the necessity and desirability to use women in their departments. Special training advisors must be selected to give women special advice and training in safety, job practice, type of dress, and other subjects connected with this new venture. In fact, a series of lectures on how to work with the other sex is of importance.

Such jobs as cranemen, tractor operators, diesel locomotive engineers, inspectors, and sheet handlers on light products, welders, mill clerks, weighmasters, dispatchers, shippers, stencillers, drill press operators, and many other jobs may be considered or women. We believe the training job for preparing women to take their place in industry will not be too difficult. In fact in some training classes in our local high school, where men and women are being trained to be welders, women have learned the job more quickly than the men, and have done their welding more neatly.

In addition to training of workmen and women, we must not forget morale building because that is also a type of training. In that connection we have appointed a responsible operating executive as the war production drive director. The chairman of our employee representative committee is his assistant. They have an executive committee consisting of an equal number of workmen and supervisors. Then in each department, the superintendent is the head of the departmental war production drive, and his departmental employee representative is his assistant. We have a departmental war production drive committee consisting of equal number of workmen and foremen.

Through these organizations we maintain and improve morale by supervising drives such as U. S. O. and war bond sales. We have had rubber and scrap drives. Every department has its war production drive bulletin board with recognition on a beautiful scroll of the names of those men who have left the department for the armed service. By means of posters, exhibits of products made from Armco sheets and plates, moving pictures, mass meetings, talks by government and army and navy representatives, visits from service men on furlough, suggestions, slogan contests, safety contests, fire fighting drills, personal interviews, and many other ways, we keep our men on their toes.

As a result they have enthusiastically tackled new products such as manufacture of armor plate in the open hearth furnaces, production of alloy propeller steel, manufacture of very large castings, assisting sub-contractors in producing equipment for the Navy, development of cartridge steel, handling very heavy steel sections on mills and equipment designed for only light gauge sheets. Our men have broken hundreds of daily, weekly, and monthly production records in recent months and have broken six consecutive monthly blast furnace production records since March 1942.

All in all the cooperation between management and men has been very satisfactory. As a result our men played their part in making it possible for Armco to be awarded the Army-Navy "E" which, to us, is an evidence that our training program has brought results.

L. F. COFFIN: What method does the Carnegie-Illinois Steel Corporation use to train millwrights to serve in those maintenance departments which do not need the apprentice background of a first-class machinist?

R. J. GREENLY: That is a good question, and I think we have anticipated it. We have definitely set up what we call a "learner program." This program functions first, to develop single-skill operators in the shortest possible time, and second, to develop millwrights or maintenance men for jobs which do not require the extensive background of formal apprenticeship.

We have fourteen apprenticeable trades in the corporation. The men who go into all other types of maintenance work are trained in a learner program, the length of training time dependent on the requirements of the specific job to be filled.

F. E. LEAHY: Would you please explain how you develop job trainers?

R. J. GREENLY: We go to the departmental superintendent and ask for his best operator to be used as a job trainer — this on the theory that you cannot teach something that you do not know. The selected operator is then given sixteen hours of classroom instruction. These classes are conducted by specialists from our Training Division who follow an outline which we have developed. The fundamental problem is to select the man who knows how to do the job and then to teach him the technique of giving instructions.

Industrial Rubber Substitutes

. . . . synthetic rubber's qualities are such that it can replace natural rubber in virtually all industrial uses . . . . with scientific control, products having almost any desired combination of physical properties can be produced . . . .

by J. D. Beebe

INDUSTRIAL PRODUCTS DIVISION

THE B. F. GOODRICH COMPANY

AKRON, OHIO

▲ YOU of the steel industry have long known the importance of rubber as an engineering material. You know the vital part rubber plays in the handling of raw materials in steel manufacturing plants. You know that our two industries — rubber and steel — have a good deal in common these days, over and above the central fact that we are both producing goods which have first rank in the victory program.

Not only do our respective industries share these opportunities and problems, but we collaborate in the production of war goods in new ways. A particularly timely example of this "wedding" of steel and rubber is in the "square wheels" — endless-band tracks of steel and rubber — which give new speed and mobility to much of the equipment of our mechanized army — the tanks, tank destroyers and "half-trac" personnel-and-equipment carriers.

They are what you might call the "racing shoes" for highly mobile, cannon-carrying tank destroyers that are capable of outsprinting their ponderous quarry over virtually any sort of battle terrain, while carrying plenty of heavy guns.

These band tracks represent more than a mere application of rubber to steel — they are a complete departure from past crawler-tractor practice, growing out of work originally undertaken by our company engineers some ten years ago in developing this type of track for farm and special industrial uses.

They are so light and flexible, relatively, that vehicles can travel almost as fast on them as on wheels — over terrain that wheels alone could not negotiate — and actually use some 200 pounds less rubber per vehicle than tires would require. They are about 63 per cent steel and 20 per cent crude rubber, the remainder being rubber compounding materials.

Our company has entered into a new and larger relationship with the steel industry in going into mass production on these band tracks, and has effected a number of manufacturing time-savers in recent months in meeting a production schedule that is about four-and-a-half times what it was less than a year ago. The division making these tracks has been on a seven-day week continuously since September of 1941, and turned out its "first ten thousand" pairs of tracks 45 days ahead of the army's schedule.

The track itself consists of a rubber band reinforced longitudinally by steel cables to which a number of steel cross members are attached at regular intervals. these cross members carry the guides and, in the case of sprocket-driven tracks, contact the teeth of the sprockets. The assembly forms a substantially inextensible structure of great strength and flexibility.

Thus, steel and rubber make possible a wide variety of army vehicles which possess new low rolling resistance, freedom from noise and vibration, higher speeds, higher traction and greater all-around efficiency.

Along with our mutual responsibilities we also share the harsh fact that our production must be achieved in the face of crucial shortages in the essential raw materials which we fashion into munitions or equipment for essential civilian purposes.

You have invited me to talk to you about "rubber substitutes" — the synthetic rubbers which our industry has been working night and day to produce in the quantities and to the standards you of the steel

Presented before A. I. S. E. Detroit District Section Meeting.

industry and others need in order to function at peak efficiency in spite of shortages of natural rubber.

Before going into the matter of synthetics, I should like to mention a few pertinent facts about the rubber situation.

Normal annual consumption of rubber in the United States amounted to approximately 600,000 long tons. In 1941, demands pushed that figure up to 766,000 long tons.

We are now faced with the fact that 90 per cent of the world's rubber sources are in enemy hands, and another 7 per cent is threatened by continuing enemy military action in that part of the world.

With rubber imports practically at a standstill, we have less than 600,000 long tons of natural rubber on hand, or approximately enough for a normal year's needs. To make that stockpile feed today's abnormally large demands for rubber as long as possible, manufacture of civilian rubber goods has been reduced more than 80 per cent under 1941, and even military requirements have been cut 20 per cent.

To many of the people in this country, the important part played by rubber in their daily lives was never fully realized until we were abruptly faced with a rubber shortage. It took a jolt as serious as that to make many of us realize for the first time how thoroughly dependent we were on rubber in every phase of our daily living, as well as in the efficient functioning of our armed forces and vital civilian services.

What many citizens still do not know, but what I am sure you appreciate, is the fact that our industrial system depends as fully on rubber as does civilian living. Our industrial production machinery could be stalled in the same sense that our transportation system and military rolling stock would be stalled for lack of rubber.

Full recognition of the seriousness of the rubber situation is expressed in the report of the able Baruch committee — I quote from that report:

Figure 1 — New type scout car for the United States Army, equipped with rubber tracks, shown in action on a military proving ground.

"We find the existing situation to be so dangerous that unless corrective measures are taken immediately, this country will face both a military and civilian collapse."

The only course left to us is to develop production of man-made rubber as rapidly as possible so that we can supplement our rubber stockpile and make it last until such time as we have enough synthetic production to meet all requirements.

At the time of Pearl Harbor, our company and a few others had sufficient synthetic capacity to give the country a total annual production of only slightly more than 30,000 long tons. Since then, the government has undertaken the building of plants to manufacture at full capacity, 875,000 long tons annually. The Baruch committee report recommended plant capacity for all kinds of synthetic rubber totalling 1,100,000 long tons.

But these plants will not reach large scale production until late in 1943, and will not reach full capacity until 1944. It is thus apparent that the critical period will be from mid-1943 until large synthetic production is attained. If we use our stockpile too fast, or if new synthetic plants are delayed, we may find ourselves without rubber we must have to wage and win this war.

You men may be especially interested to know that it was in connection with a problem involving a "wedding" of steel and rubber that the writer's company first began the research work in synthetics which it has carried on for many years. We had developed a method of obtaining remarkable adhesion between rubber and steel — we called this the Vulcalock process. The basic material used was an isomer of rubber. Dr. Waldo L. Semon of our research laboratories was given the job of determining whether that product could be made synthetically from non-rubber materials.

Out of his research came the discovery of Koroseal — a rubber-like thermoplastic material which is one of the most versatile of modern synthetics.

Koroseal has found wide use in the industrial and domestic fields. One of the most important uses is as a sheathing for electric cables. The material has excellent electrical properties, is non-flammable, and almost inert — not affected by oxidation or corrosive chemicals. It is also used for tubing and a wide variety of molded parts. In the domestic field, Koroseal coated fabric is used for raincoats, umbrellas, shower curtains and hundreds of other items.

While still engaged in Koroseal research, Dr. Semon was given the assignment of developing a synthetic material that more nearly matched the characteristics of natural rubber. The answer that he and his staff made to that challenge was Ameripol.

Ameripol is one of the butadiene rubbers which I shall discuss more fully a little later on. We chose the name because the product achieved the characteristic rubber-like linkage of the molecules through polymerization of American materials.

Our company has long stressed the necessity of developing synthetic production capacity. At the same time we have emphasized the importance of acquiring knowledge of synthetics' potentialities. It was for that reason that we made automobile tires with Ameripol available to the American public as early as June 1940,

when their cost had to be considerably higher than that of natural rubber tires.

Knowing that 70 per cent of the country's rubber imports went into tires, we felt it essential to get experience in the use of synthetics in tire making, and to have a record of performance of "general purpose" synthetics under normal conditions.

Industries such as you represent have for a number of years been using synthetic rubbers. You have known them as "special purpose" rubbers. You were aware of their existence and their value for specific purposes long before the general public began to think about synthetic rubber.

I would like to give you a few examples where synthetic rubbers are being used very successfully:

You will find them in hose of all types used for handling petroleum products — this includes "bullet sealing hose" used on military aircraft and vehicles. They are also used for making "bullet sealing gasoline tanks" for aircraft and for the fittings used with such tanks. In fact, the main use today is in service conditions where high resistance to oil is vital to the efficiency of the product. Here are some more places where American synthetic rubbers are giving successful service — though you must realize that at the present time they are not being made for some of these purposes, because of prior military demands:

Figure 2 — Rolling into action on rubber — four of the Army's speedy scout cars follow a river bed in maneuvers. These new mobile units, mounting three machine guns, have bullet-proof tires and tubes.

You will find synthetic rubber in gaskets for windshield wipers and for pistons, journal boxes of mine cars, refrigerators, greasing equipment, transformers, fuel oil gauges, pneumatic tools, carburetors, airplane engine parts, fire-fighting equipment, and in shock absorbers You will find it in printing rubbers, in compounds for bonding abrasive wheels, in parts used in making spark plugs, and in platens for typewriters and business machines.

The basic raw materials of the various synthetic rubbers — salt, coal, limestone, water, petroleum, sulphur, grain alcohol, and natural gas — are plentiful and can be had almost for the asking. But they must be subjected to complicated chemical processing before they will yield such immediate raw materials as acetylene, hydrogen chloride, sodium polysulphide, ethylene dichloride, butadiene, styrene, and isobutylene.

Of the synthetic rubbers which our government has now authorized industry to produce in large enough quantities to fill military and other essential needs as rapidly as possible, four types predominate — they are:

1. Neoprene — which is made from chloroprene, produced by combining hydrogen chloride and divinyl acetylene. It has high oil resistance, tensile strength, and abrasion resistance, and can be made into tires.

2. Thiokol — a combination of ethylene-chloride and sodium polysulphide created from sulphur, salt and crude oil. This product's chemical and molecular structure differs more from natural rubber than do those of the others. It has exceptionally high resistance to oil and retreads made with it are serviceable when driven at speeds under 40 miles an hour.

3. Butyl — made principally from isobutylene obtained from petroleum. It has high chemical stability. Its production costs are low, but it is hard to process.

4. Butadiene rubbers — these are the most important of the synthetic rubber and will be produced in quantities which will far exceed the combined production of the other three types. These rubbers are co-polymers of butadiene and other materials, for example — a co-polymer of butadiene and styrene produces a synthetic which has high resistance to abrasion and can be used in the manufacture of tires. A co-polymer of butadiene and acrylonitrile produces a synthetic which has high oil resistance and is used in the manufacture of hose for handling petroleum products and other products where high resistance to oil is essential.

The important raw material necessary to produce these synthetics is "butadiene". This can be obtained as a by-product in the petroleum industry or it can be made synthetically starting with grain alcohol.

You are all aware of the discussion as to which source of butadiene should be developed. Our company has had successful experience in making synthetic rubbers with butadiene from each of these sources. The government program now calls for production of butadiene from both of them.

I just wanted to make it clear that we are completely concerned with the job of making synthetic rubber from butadiene, not with production methods or differences in primary sources of this raw material. We need butadiene, and fast. Certainly concentration on the quick completion of the present program is the important thing today.

We need enough synthetic rubber, on time; not too much — too late.

One very desirable characteristic possessed by natural rubber and not by butadiene rubber is what the rubber manufacturers terms "building tack". In the uncured state natural rubber is "sticky" — this facilitates the

building of a product before vulcanizing. Butadiene rubbers are dry in the uncured state — this makes necessary the development of processing methods — of acquiring what we term the "know-how" so vitally necessary to the successful use of synthetic rubbers.

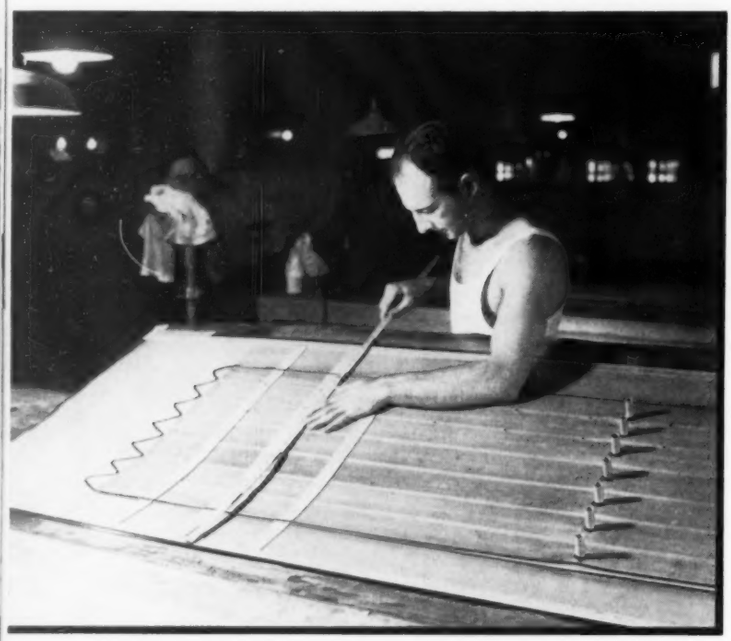

Figure 3 — Aircraft de-icers are now used as standard equipment on military aircraft. These American safety devices have seen much combat service in the skies of Europe since the beginning of World War II.

Figure 4 — A marksman behind the sights of a 50 caliber machine gun during firing tests of the bullet-sealing fuel hose, which protects vital fuel systems of combat airplanes.

A great amount of research on synthetics of this type is being carried on. It is entirely possible that one result of this research may be the discovery of a synthetic rubber which will possess this much desired "building tack" and thus simplify many problems now facing us in the processing of this material.

We have been assured that the cumulative experience gained since our first venture into the manufacture of synthetic rubber for civilian use, plus the "know-how" our company and others acquired in "special purpose" rubbers, are important assets on the side of the United Nations today. The rubber companies have pooled their manufacturing "know-how" to speed the production of general purpose synthetic rubbers.

Let us examine the relative physical characteristics of synthetic and natural rubbers.

As a matter of fact, the physical properties of synthetics are responsible for the fact that the very meaning of the word rubber has a new connotation today. Rubber no longer signifies a particular hydrocarbon material, but has been widely adopted to characterize a class of substances similar physically to natural rubber regardless of their chemical composition. In order to qualify as a rubber, material should stretch readily to a considerable degree and, after release, retract forcefully and quickly; but no specific criteria have been generally accepted limiting the values for these properties.

In general, true enough, it is extremely difficult to develop a synthetic which excels natural rubber in the two characteristics with which the layman is familiar: resiliency and extensibility, or "bounce and stretch."

But synthetic rubbers are demonstrably superior to natural rubber at so many points throughout the whole broad range of engineering and industrial uses, that they more than compensate for the fact that a ball of synthetic rubber may not bounce as high as one of natural rubber.

The most generally recognized virtue of some synthetics over natural rubber is their resistance to oil and organic solvents. They are characterized by low oil absorption, by their longevity and their ability to withstand the corrosive action of chemicals.

Some synthetics are resistant to the oxidizing influence of metallic soaps used as driers in paints and inks. Their resistance to heat is extraordinary — especially oxidization at high temperatures. They can be highly resistant to abrasion, even in cases where oil is also present.

In short, synthetic rubber's qualities are such that it can replace natural rubber in virtually all industrial uses, and in addition can often be used where natural rubber is impractical.

I should like to give two examples:

Water-lubricated rubber bearings are commonly used for the outboard bearings of propeller shafts on vessels plying in silt-bearing waters. The rubber is deformed by any particles of sand which enter between it and the metal shaft, and these particles travel along the shaft and are expelled without scoring the metal. In exceedingly muddy water such as is produced by the cutter heads of dredges, rubber bearings have yielded extraordinarily long service.

When, however, bearings of this sort were used on vessels at Maracaibo, Venezuela, where the surface

water was covered with a film of oil from neighboring wells, the rubber swelled and softened and the bearings soon failed. Substitution of bearings made of synthetic rubber compounds which are not swollen or deteriorated by oil overcame the difficulty.

Another superiority of some synthetics lies in their resistance to "checking" in sunlight. This fact led to the adoption of a synthetic as a surafce coating for rubber airplane de-icers exposed at times to bright sunlight which induced checking and cracking.

It seems to me that in synthetic rubber's ability to do most of the things that natural rubber can do, plus many of the things natural rubber cannot do, lies the key to the importance of synthetic rubbers as engineering materials of today and tomorrow.

Even today's relatively small synthetic output has made possible prices and costs that are on the way to being competitive with those of natural rubbers. And the cost curve will drop inevitably as production capacity mounts.

Thus we are entering an era when rubber can be "tailor made", and at reasonable cost. That has not always been possible with natural rubber. Like any other agricultural product, it is subject to variations that no amount of skill can completely control.

Synthetics, on the contrary, are responsive to rigid scientific control.

We know today that tomorrow's industrial chemist will produce specific synthetic rubber compositions to do specific jobs. He will be able to control the hitherto variable factors and make a variety of completely uniform products having almost any desired combination of physical properties.

Tread wear, heat resistance, electrical resistance, flame resistance, resistance to ozone and oxidizing chemicals, resistance to swelling and penetration by oil — these are the characteristics which are important to you who use rubber as an engineering material. You will be able to demand them in any degree and in any combination from the synthetic rubbers of tomorrow.

And the chemists, knowing your exact requirements for a given purpose, will be able, very often, to give you a product that will outperform natural rubber and hence contribute to the heightened efficiency of industrial operations.

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LARGEST Buick automobile dealer in the world is the Glidden-Buick Company of New York. Over 8,000 new and used cars sold . . . 53,000 serviced . . . was the impressive total recorded by this firm in 1941.

Then – Pearl Harbor, and Glidden-Buick, like many other civilian business enterprises determined to find an active role in America's war effort. With the assistance of Air Reduction service engineers a study was made of the likeliest fields of activity, and plans were drawn up for conversion of Glidden-Buick's repair shops to essential war work.

Within three months, well equipped welding shops in Glidden-Buick's plant were producing aircraft parts for many important Eastern aviation manufacturers. Today, this typical American peacetime firm is turning out highly specialized aircraft assemblies in a steadily increasing volume. Employing a large staff of men and women welders, Glidden-Buick has now become one of the outstanding producers of vital aircraft parts.

In hundreds of cases specialized "know how" of Airco engineers, pooled with a customer's intimate knowledge of his problem, has speedily solved urgent manufacturing difficulties. This is in keeping with Air Reduction's established policy of providing maximum service to its customers in the application of oxyacetylene and electric arc processes. If you have any problems involving the use of these processes, communicate with your nearest Airco office.

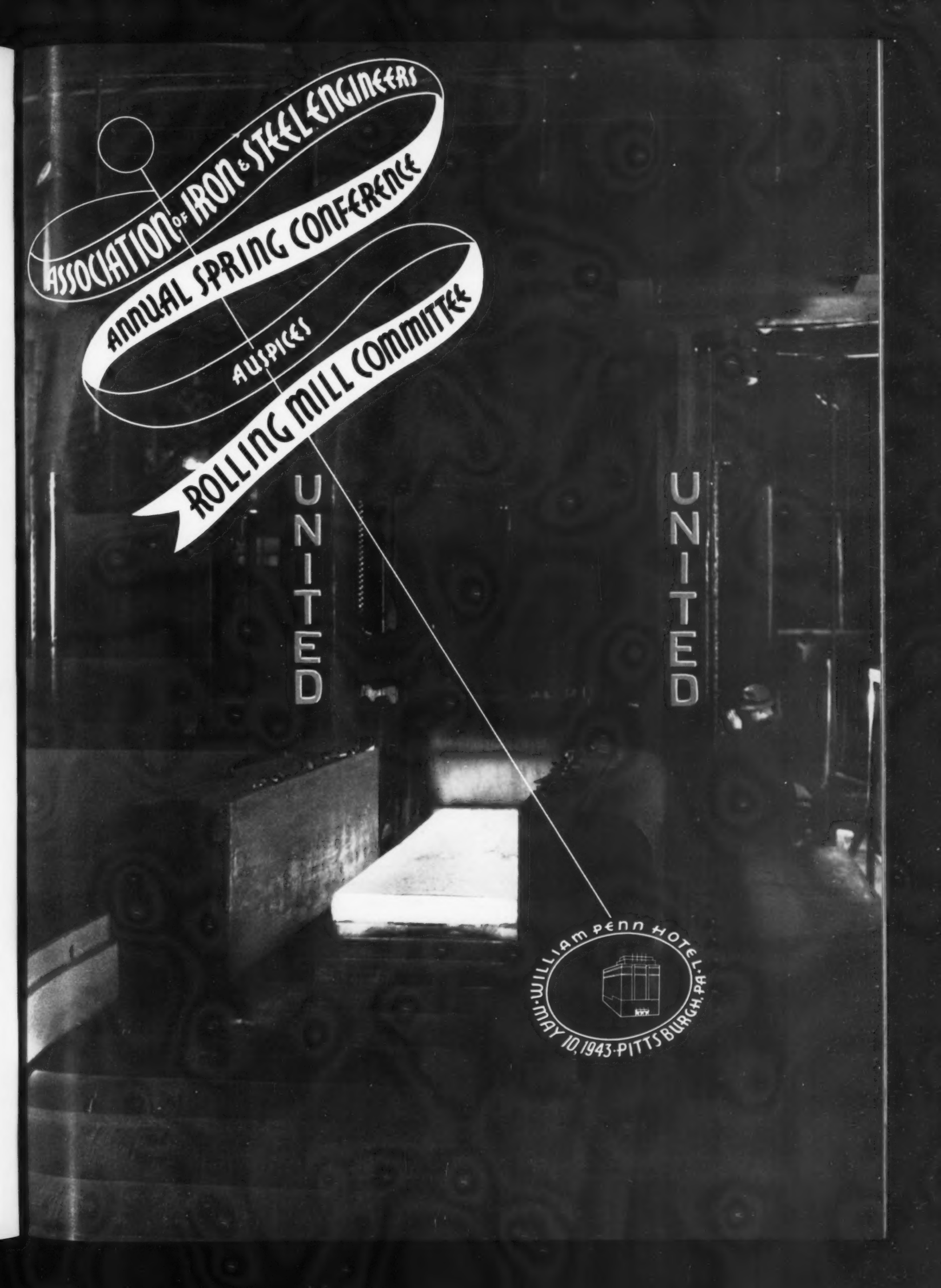
Air Reduction

General Offices: 60 EAST 42nd ST., NEW YORK, N. Y.

IN TEXAS
MAGNOLIA-AIRCO GAS PRODUCTS CO.
General Offices: HOUSTON, TEXAS
OFFICES IN ALL PRINCIPAL CITIES

AIRCO WILSON

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*


ASSOCIATION OF IRON & STEEL ENGINEERS
ANNUAL SPRING CONFERENCE
AUSPICES
ROLLING MILL COMMITTEE
UNITED
UNITED
WILLIAM PENN HOTEL
MAY 10, 1943 · PITTSBURGH, PA.

H. G. R. BENNETT

FREEMAN H. DYKE

H. H. TALBOT

O. A. BAMBERGER

ALEX MONTGOMERY, JR

Programme

General Chairman — H. G. R. BENNETT
Engineer, Hot Rolling Mills
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

10:00 A.M. — REGISTRATION — Silver Room

1:30 P.M. — *Technical Meeting* — Urban Room

Chairman:
FREEMAN H. DYKE
Superintendent, Blooming, Bar and Hot Strip Mills
Wheeling Steel Corporation
Steubenville, Ohio

Vice-Chairman:
J. D. JONES
Chief Engineer
Youngstown Sheet and Tube Company
Youngstown, Ohio

"A New Soaking Pit Design," by JOSEPH SPARKS, Swindell-Dressler Corporation, Pittsbrugh, Pennsylvania.

"Main Roll Drives for Blooming and Slabbing Mills," by RALPH WRIGHT, Industry Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

William Penn Hotel, Pittsburgh, Pa.

RALPH WRIGHT

J. C. MURRAY

"Design of Blooming Mill Elements," by H. H. TALBOT, Senior Engineer, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

6:30 P.M. — DINNER — Urban Room
(Speaker to be announced)

LOUIS MOSES

8:00 P.M. — *Technical Meeting* — Urban Room

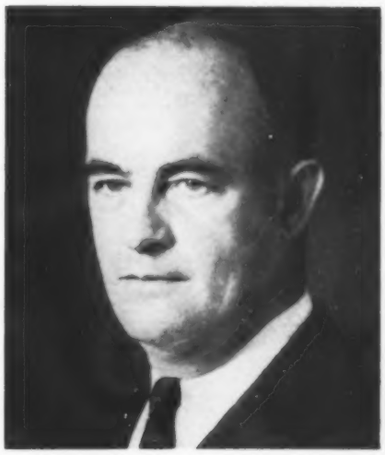
Chairman:
LOUIS MOSES
Superintendent, Rail Mill and Roll
Roll Department
Bethlehem Steel Company
Sparrows Point, Maryland

Vice-Chairman:
J. C. MURRAY
Assistant General Superintendent
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

JOSEPH SPARKS

J. D. JONES

"Scheduling the Primary Mills," by ALEX MONTGOMERY, JR., Superintendent of Rolling and J. B. HOLBROOK, Assistant to Superintendent of Production Planning, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.



"Prevention of Flaking in Hot-Worked Sections," by O. A. BAMBERGER, Superintendent, Mechanical Department, Republic Steel Corporation, Massillon, Ohio.

Monday, May 10, 1943

A MESSAGE TO THE...

Men of the Steel Industry!

F. E. FLYNN, *President*

This year brings another important step in the Association's program of advancing the technical and engineering phases of the production and processing of iron and steel. In response to many requests from Association members and from others throughout the industry, we have formed a special Rolling Mill Committee to plan activities specifically designed to meet the problems of the rolling mill men. No other group has devoted the attention to the rolling mill that has been given to it by the Association of Iron and Steel Engineers, and no other group is as well fitted to carry this work further. Already, the continuous strip mill has been exhaustively covered. The Rolling Mill Committee has decided that blooming and slabbing mills should be the next step, with billet mills, bar mills, etc., following.

We therefore offer this 1943 annual spring meeting, devoted to blooming and slabbing mills, under the auspices of the Rolling Mill Committee. The current issue of our journal, The Iron and Steel Engineer, also includes a considerable collection of blooming and slabbing mill data. We hope this meeting will be the start of lively, healthy activities devoted to the vital topics of rolling mills. It can be such only if the mill men in the industry cooperate through a free exchange of experience and ideas. The sum of these scattered experiences and ideas represents a staggering total of "know-how," which cannot help but benefit our industry.

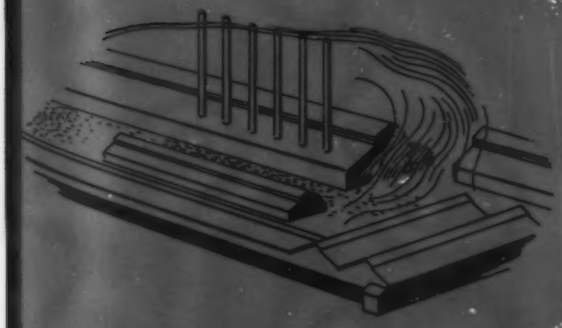
We sincerely hope that you will be able to take advantage of this invitation to attend this meeting, to participate in its discussions and to lend your aid in furthering this work.

F. E. Flynn

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building - Pittsburgh, Pennsylvania

THE MODERN SOAKING PIT



AND BLOOMING MILL

Meet the Mighty Grand-dad of a thousand Tools of War!

He's big! He's tough! He's a Blooming Roll! He breaks ingots down into slabs or blooms. He, and his companion Ohio Rolls, are withstanding the terrific abuse of record-smashing steel production, and are rolling out the weapons that are rapidly rolling on to Rome, to Berlin, to Tokyo.

ARMY E NAVY

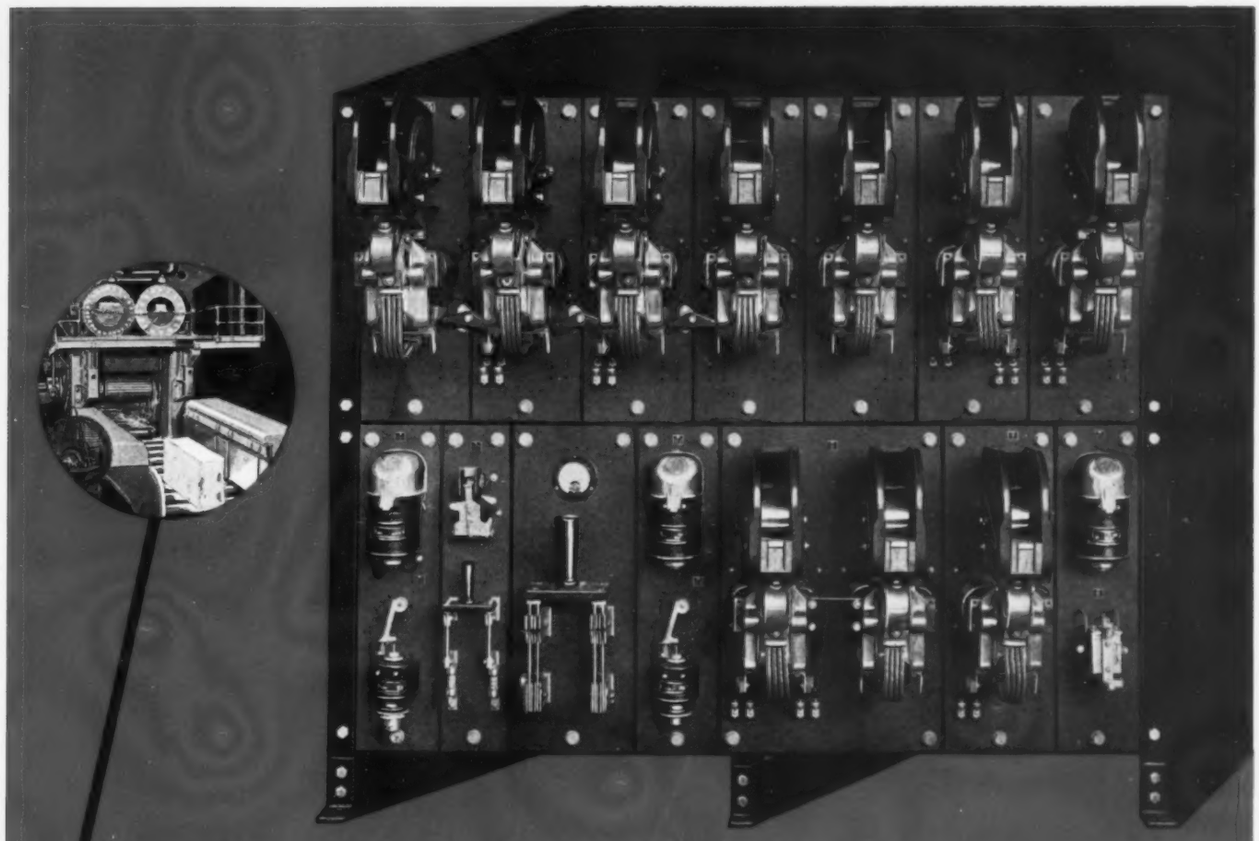
THE **OHIO STEEL FOUNDRY CO.**

LIMA, OHIO • SPRINGFIELD, OHIO

ENGINEERS • FOUNDERS • MACHINISTS

Ohio Rolls

CARBON STEEL ROLLS • ALLOY STEEL ROLLS • ALLOY IRON ROLLS • FLINTUFF ROLLS • NICKEL CHILL ROLLS • PLAIN CHILLED ROLLS • MOLYBDENUM CHILL ROLLS • DENSO-IRON ROLLS • HOLL-O-CAST ROLLS



EC&M *LINE-ARC* CONTACTOR RHEOSTATIC CONTROL *for* BLOOMING MILL AUXILIARY DRIVES

An extra ingot an hour has been obtained since installing the above EC&M Screwdown Controller with *LINE-ARC* Contactors.

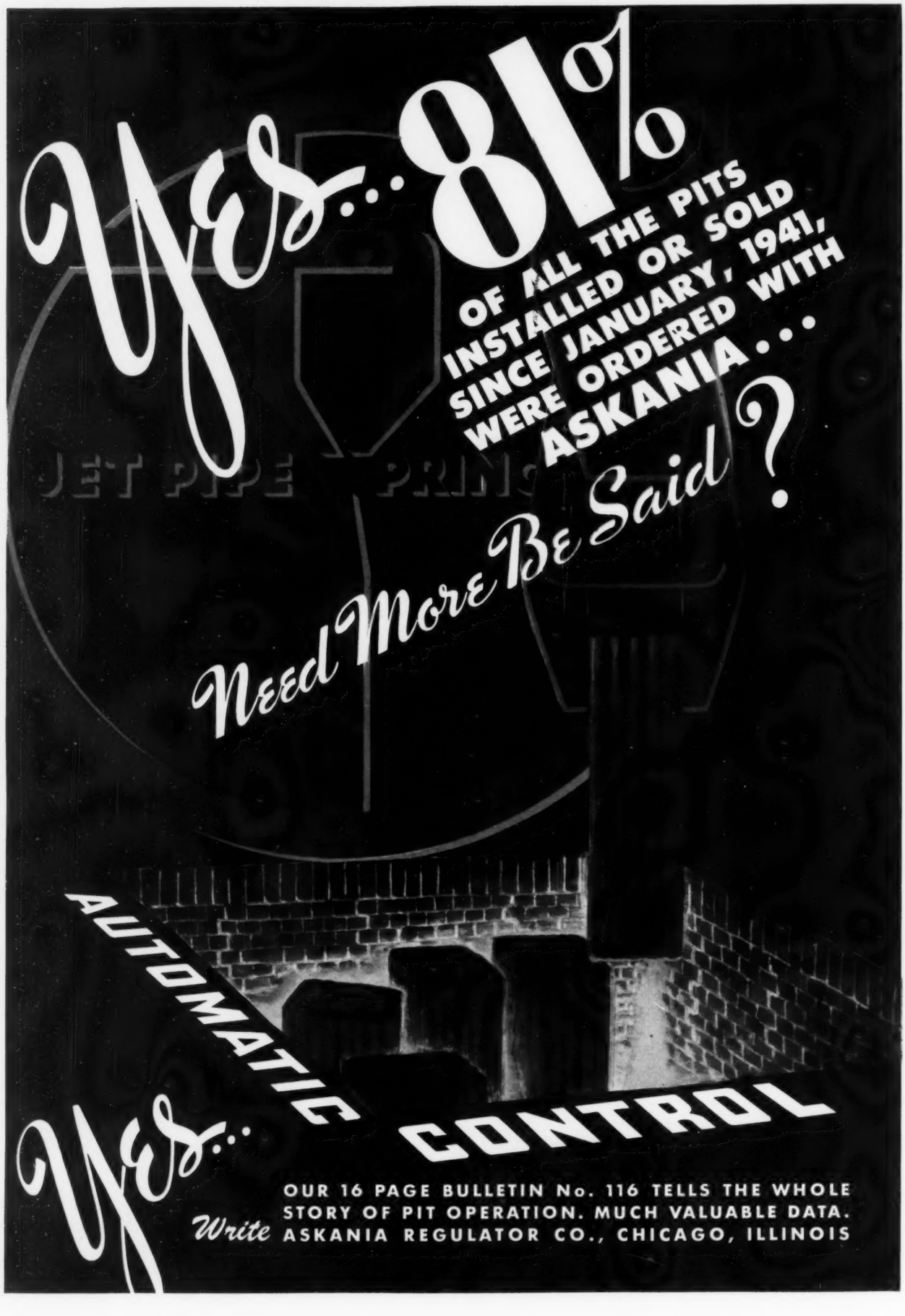
You will find EC&M Rheostatic Control on many other mills and particularly on mills that are breaking *all* the records.

THE ELECTRIC CONTROLLER & MFG. CO.
Cleveland Ohio

Yes...81%

OF ALL THE PITS INSTALLED OR SOLD SINCE JANUARY, 1941, WERE ORDERED WITH ASKANIA...

Need More Be Said?



Yes... AUTOMATIC CONTROL

OUR 16 PAGE BULLETIN No. 116 TELLS THE WHOLE STORY OF PIT OPERATION. MUCH VALUABLE DATA.

Write ASKANIA REGULATOR CO., CHICAGO, ILLINOIS

CINDER CARS FOR
- BLAST FURNACE
- OPEN HEARTH
- ELECTRIC FURNACE

SERVICE

SINGLE POT, TWIN POT, CRANE, AIR, STEAM OR MOTOR DUMP. NEW DESIGN PERMITS DUMPING TO EITHER SIDE BY OPERATOR STANDING AT GROUND LEVEL.

M. H. TREADWELL CO.
SALES OFFICES

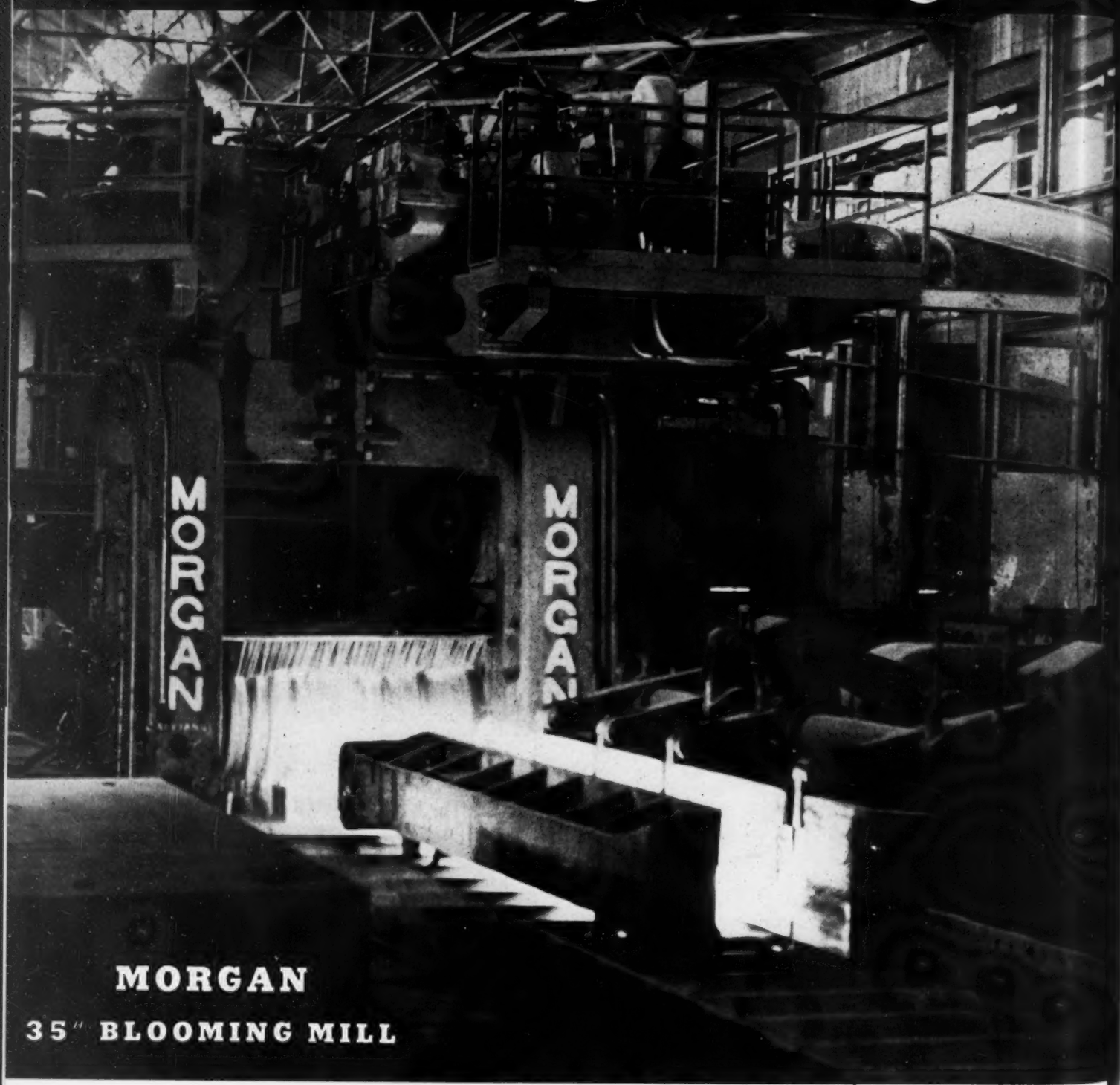
208 S. LASALLE STREET
CHICAGO

2113 FARMERS BANK
PITTSBURGH

140 CEDAR STREET
NEW YORK

TREADWELL

BUILT BY MORGAN *Engineering*



MORGAN
35″ BLOOMING MILL

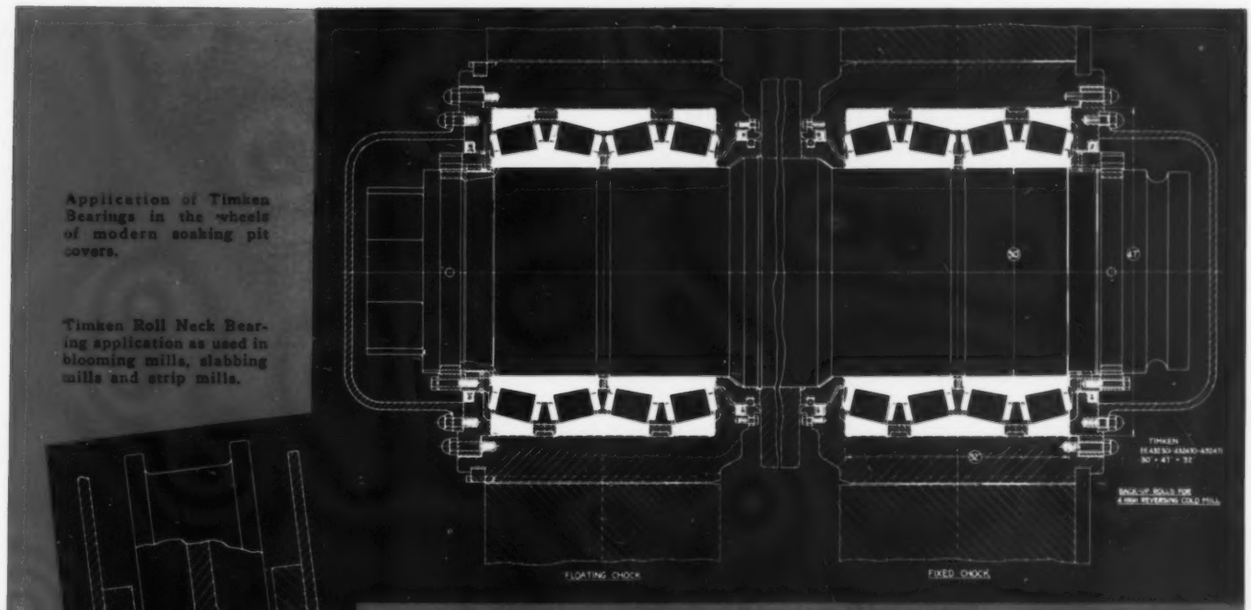
ABOVE is shown a Morgan 35″ two-high blooming mill complete with double manipulator, front and rear tables. A hydraulic roll changing device is provided. Housings are one-piece steel castings of the closed top type. Top roll balance is of the counterweight type.

Manipulator is of the overhead type, compact and accessible. Tables are of heavy design, equipped with anti-friction bearings. Screw-down drive is arranged to provide crane hook access when changing guides. Provision is made for automatic lubrication and exclusion of scale and dirt.

★ **DESIGNERS • MANUFACTURERS • CONTRACTORS**
BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
★ ELECTRIC TRAVELING CRANES • CHARGING MACHINES
INGOT STRIPPING MACHINES • SOAKING PIT CRANES
★ ELECTRIC WELDED FABRICATION • LADLE CRANES
STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS
★

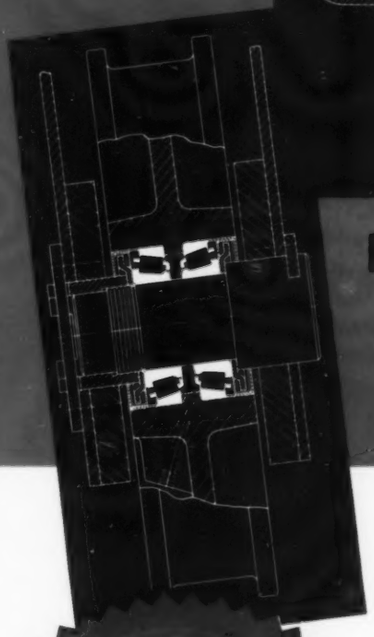
THE MORGAN ENGINEERING CO., Alliance, Ohio

★ Pittsburgh, 1420 Oliver Building



Application of Timken Bearings in the wheels of modern soaking pit covers.

Timken Roll Neck Bearing application as used in blooming mills, slabbing mills and strip mills.



Put TIMKEN BEARINGS in your Soaking Pit and Blooming Mill Equipment for Truly Modern Performance . .

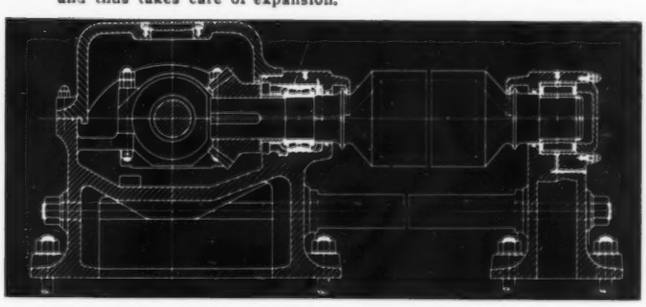
Don't wait to see what will happen after the war; begin to safeguard your future position now. Put your equipment in condition to meet any competitive challenge. Redesign to use Timken Bearings at every suitable position.

New equipment isn't necessarily *modern* equipment; *performance* is the test. This is true not only of soaking pits and blooming mills but of any kind of equipment.

Soaking pit covers and cover drives operate easier and faster and need less attention for lubrication and maintenance when Timken Tapered Roller Bearings are used at the points of friction and hard service. So do soaking pit cranes, crane tong controls and tong drives.

Likewise, on blooming and slabbing mill roll necks, screwdowns, drives and table rolls, Timken Bearings step up speed, promote operating accuracy and increase endurance. They have proved their worth in many of America's largest mills. For further information consult the equipment builder or our engineers. The Timken Roller Bearing Company, Canton, Ohio.

Timken Table Roll Bearing application. The use of a straight roller bearing at the opposite end permits the roll to float and thus takes care of expansion.

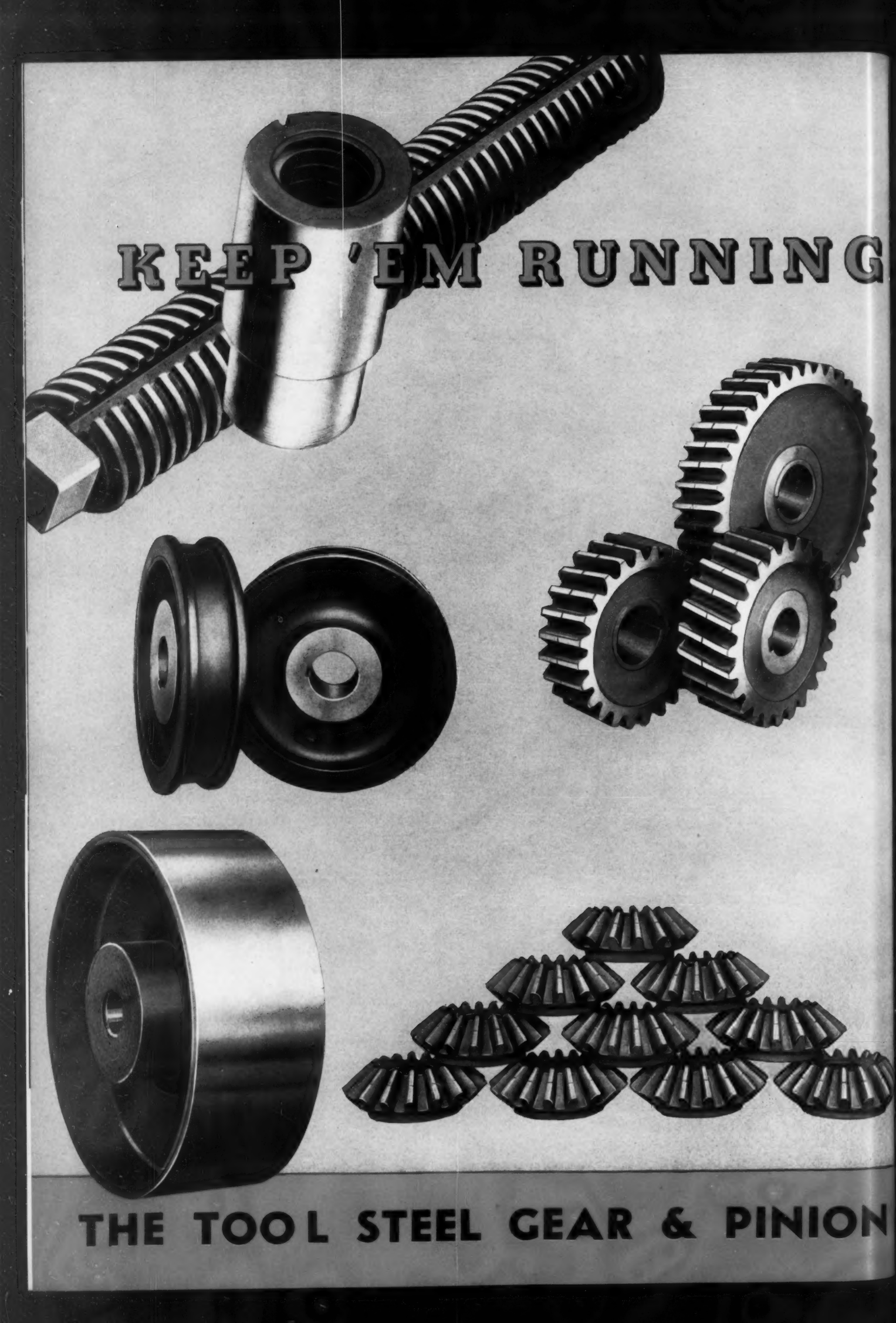


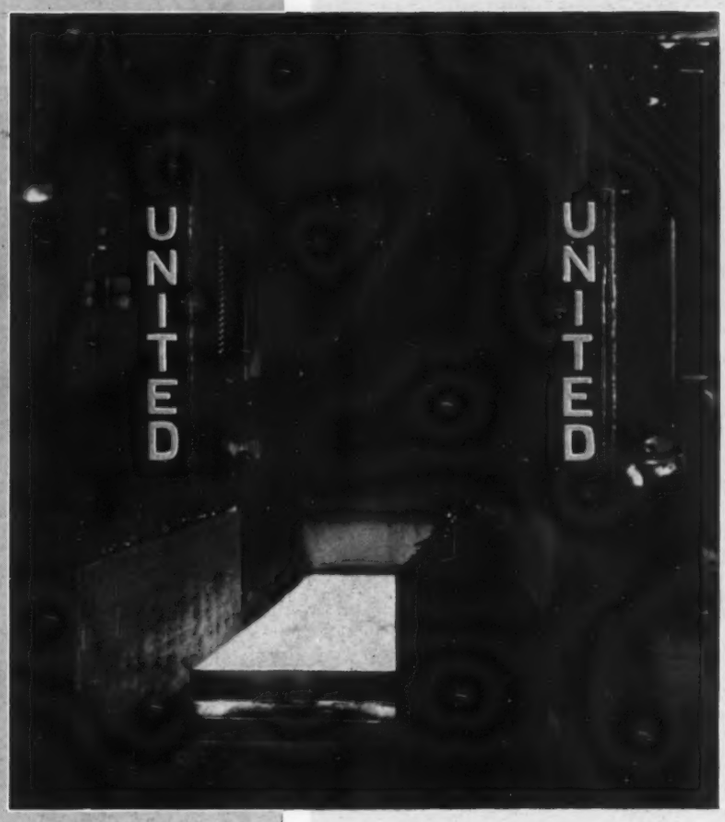
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

"ALL THERE IS IN BEARINGS"


KEEP 'EM RUNNING
THE TOOL STEEL GEAR & PINION



. . . THE BLOOMING MILLS

must be kept going full blast to keep Hitler's stooges moving in reverse.

And that's where "TOOL STEEL" Gears, Pinions, Screws and Hardened Products are doing their bit

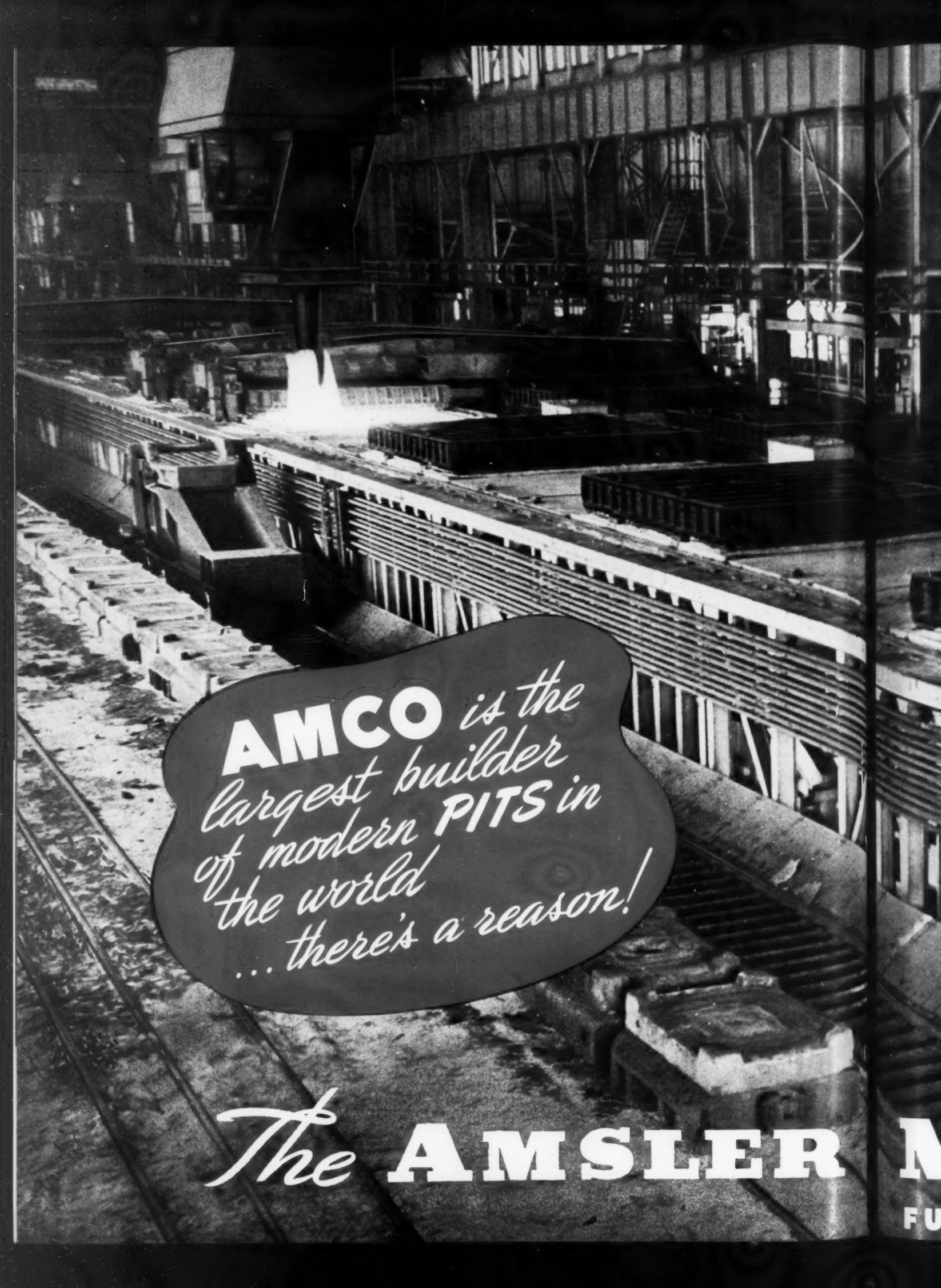
They're tough and just don't break down on the hardest kind of a job, and as for wear—well, years are for them what days and weeks are for ordinary products.

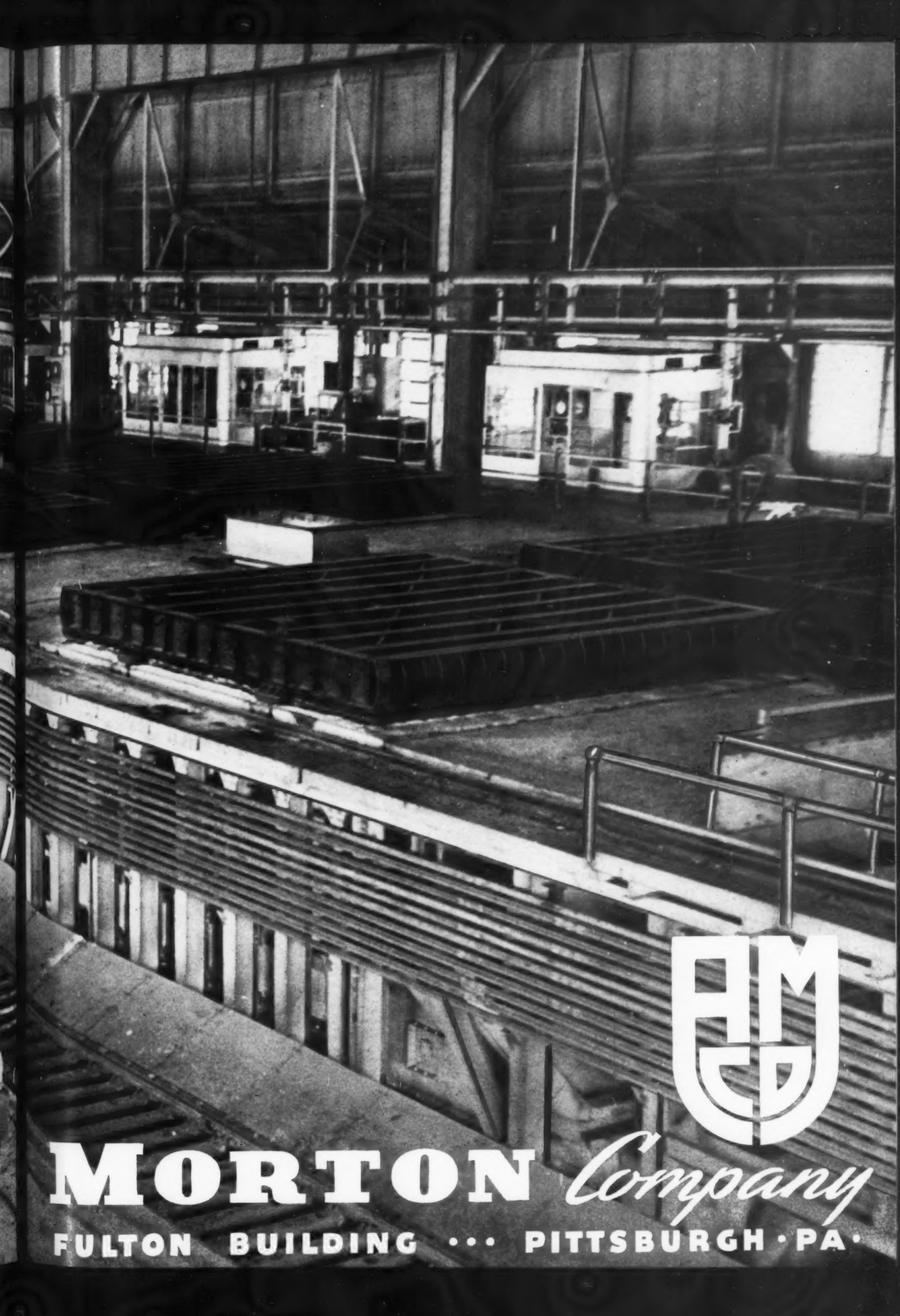
INSTALL "TOOL STEEL" Hardened Products and forget about stoppages and maintenance costs. Write for bulletins. We've plenty of proof in actual records showing what "TOOL STEEL" Products have done and are doing.

TYPICAL "TOOL STEEL" HARDENED PRODUCTS

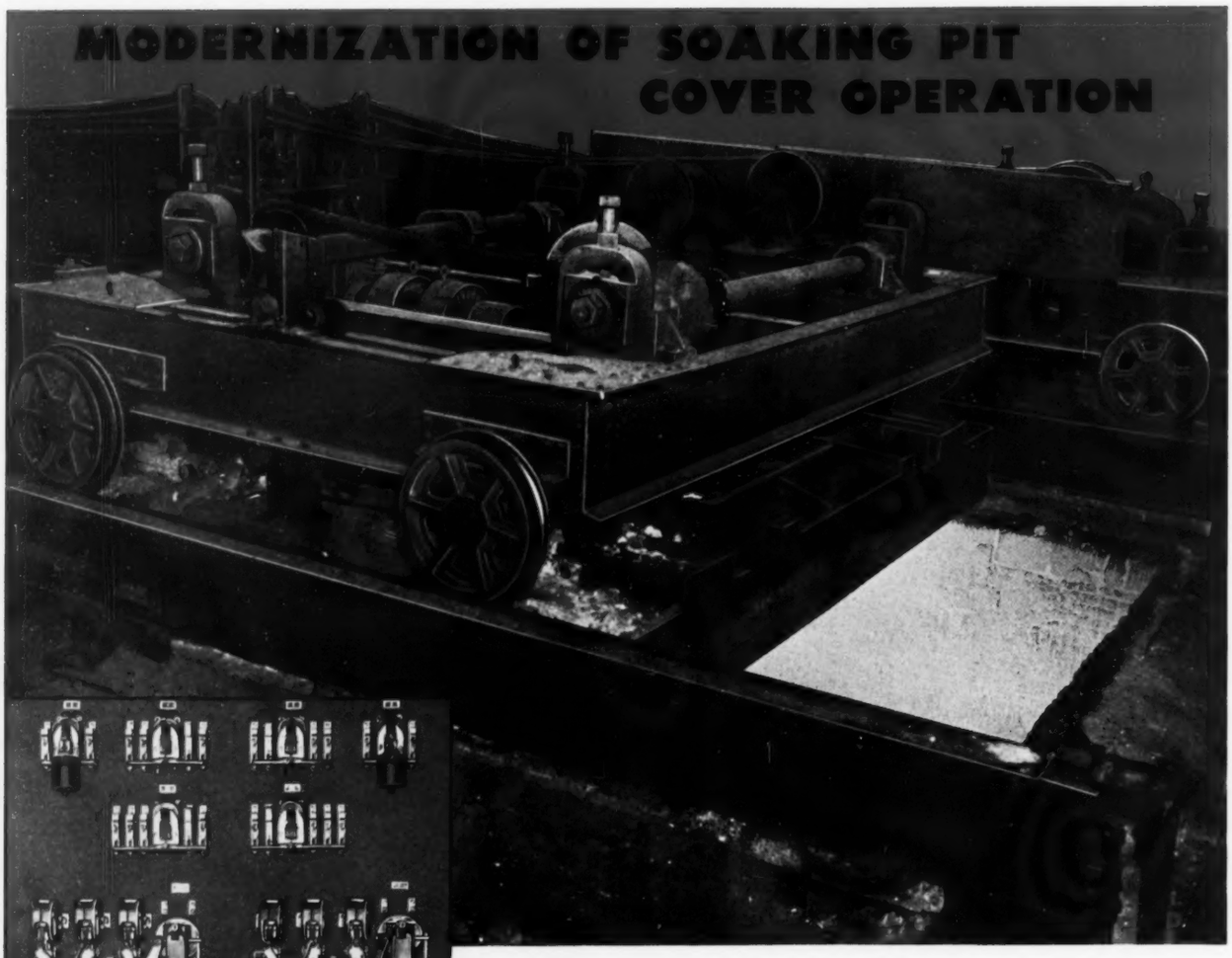
Crane Gears • Brake Wheels
Crane Wheels • Table Bevels
Herringbone Mill Pinions • Screw Down Screws & Nuts

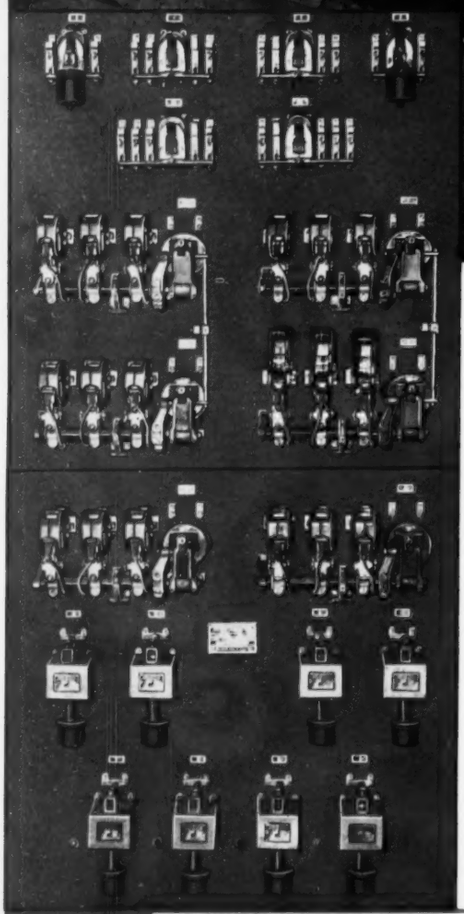
CO. . . . CINCINNATI, OHIO


AMCO is the largest builder of modern PITS in the world ... there's a reason!
The AMSLER M
FU


MORTON Company
FULTON BUILDING ··· PITTSBURGH · PA ·

MODERNIZATION OF SOAKING PIT COVER OPERATION





This "3C" Soaking Pit Cover Control is one of several installed in a large Steel Mill over a period of years. The repeat orders received, as modernization continued, are indications of satisfactory operation.

This control features fast Hoisting and Lowering of 15 H. P., A. C. Hoist Motors, with provision for slow-down to prevent jarring of cover during operation, as well as providing accurate sealing of cover to pit, and control for 10 H. P., A. C. Traverse Motors.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

HEAT TREATING CAPACITY

FOR PLATE AND CASTINGS . . . *with uniform*

precision under positive temperature control!

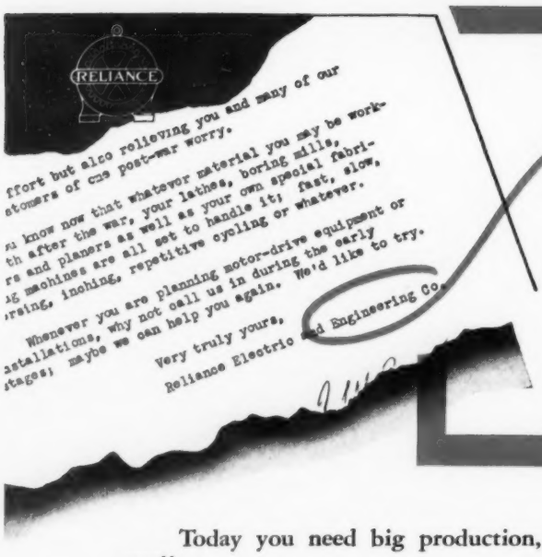
SWINDELL

CAR-BOTTOM FURNACES

SWINDELL-DRESSLER *Corporation*

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH, PA.


RELIANCE
ffort but also relieving you and many of our
stomers of the post-war worry.
u know now that whatever material you may be work-
th after the war, your lathes, boring mills,
rs and planers as well as your own special fabri-
ng machines are all set to handle it; fast, slow,
raing, inching, repetitive cycling or whatever.
Whenever you are planning motor-drive equipment or
stallations, why not call us in during the early
stages; maybe we can help you again. We'd like to try.
Very truly yours,
Reliance Electric and Engineering Co.

These two words make motor-drive more than power!

Today you need big production, high quality.

Tomorrow? The same requirements, probably; but with new methods and processes.

Fortunately, in your motor-driven equipment you can meet today's needs and, at the same time, be preparing for tomorrow's unknown demands. It takes good motors AND ENGINEERING.

Adapted to your needs, Reliance motor-drive can do *many things* for you.

If you design or use motor-driven machines or equipment, you need to get the right answer to this question: *"What can we make a motor do besides supply power?"*

Reliance Application Engineers—production-minded men with wide experience in providing flexible power and control through the use of motor-drive—can help you get the answer.

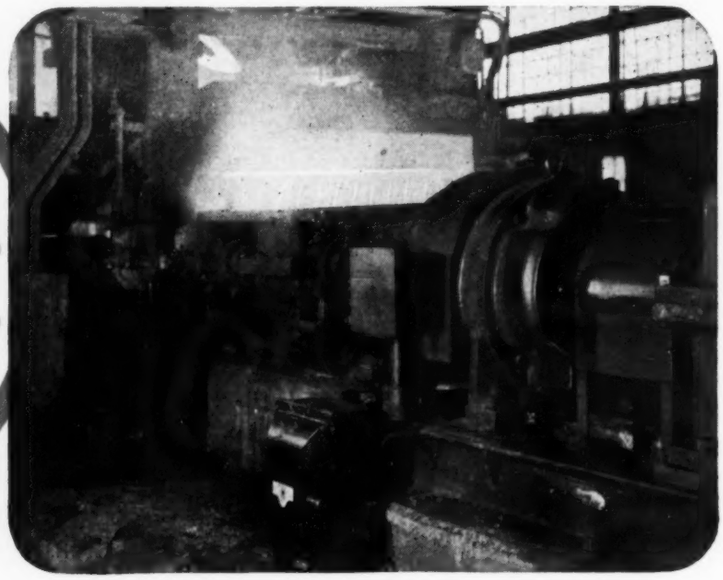
You will like the way they work. Just phone or write to our nearest office.

Motor-drive provides within itself a means of:

Speed Control	Reversing
Braking	Remote Control
Tandem Operation	Controlled Acceleration
Tension Control	Safety

Slow Speeds for inching, threading, inspection

Applying them to boost production and improve quality is APPLICATION ENGINEERING. That's our business.

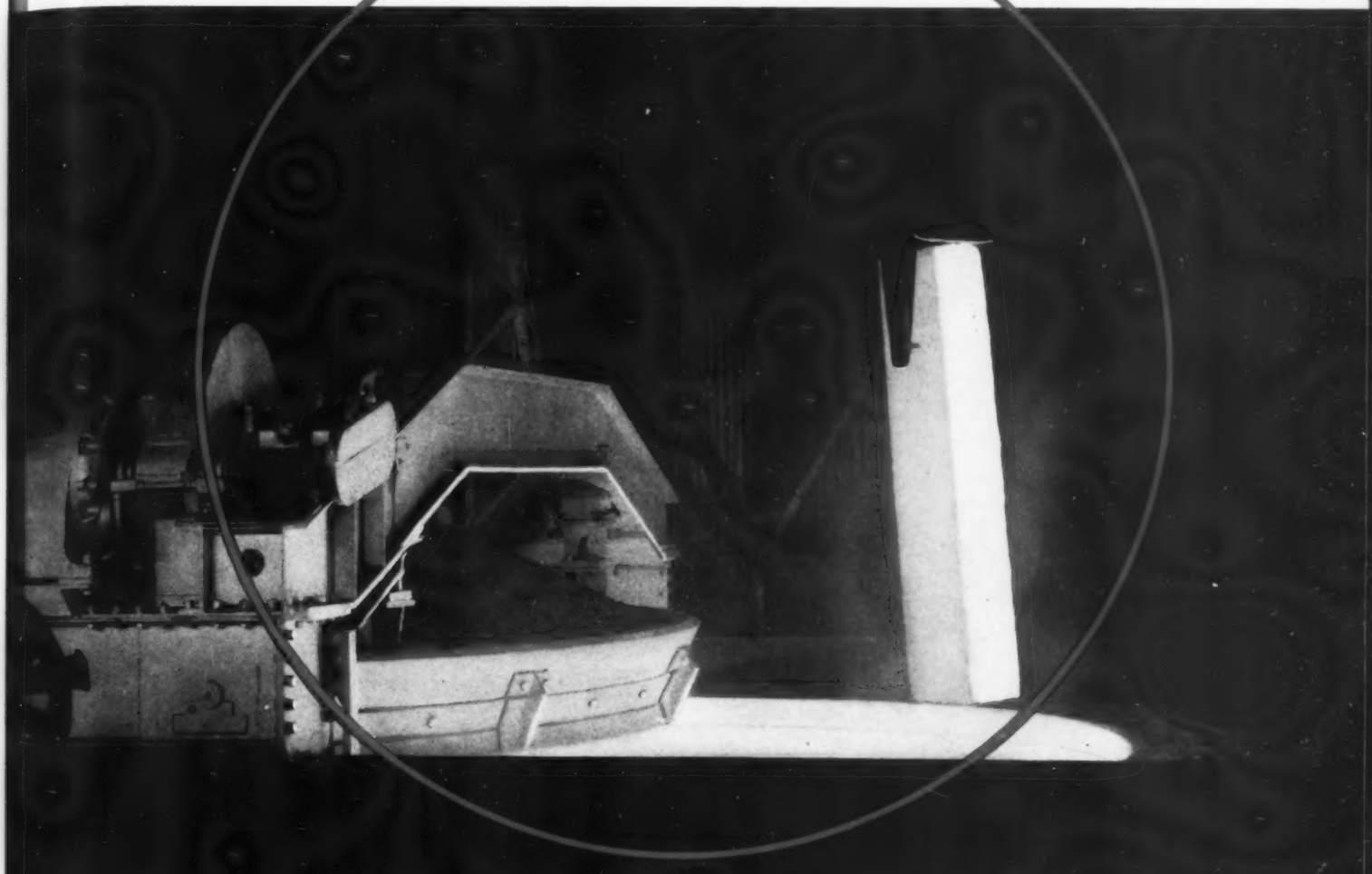


A Reliance 50 hp. Squirrel-cage motor, specially designed to operate the geared table between stands of this hot blooming mill, is demonstrating decided advantages over the d-c. mill-type motors customarily used—lower initial cost, simpler parts and less "time-out" for maintenance; splash-proof to withstand flying scale; rugged, with roller bearings, to withstand continual starting, stopping and reversing as the bloom is manipulated.

RELIANCE ELECTRIC & ENGINEERING CO.
1088 Ivanhoe Road • Cleveland, Ohio
BIRMINGHAM • BOSTON • BUFFALO • CHICAGO
CINCINNATI • DETROIT • GREENVILLE, S. C.
HOUSTON, TEX. • LOS ANGELES • MINNEAPOLIS
NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, ORE. • ST. LOUIS • SAN FRANCISCO
SYRACUSE, N.Y. • AND OTHER PRINCIPAL CITIES

RELIANCE A-C D-C MOTORS

Salem Circular Soaking Pits



BIGGER PRODUCTION • HIGHER YIELD • BETTER STEEL

SALEM SOAKING PITS are in reality circular shaped Ingot Heating Furnaces. They heat cold or hot carbon steel or alloy ingots 25% faster, while at the same time they prepare ingots better for first-class rolling at lower cost. Production data also reveals a 25% increase in tonnage. More accurate control of ingot temperatures than with other types permits a 1% reduction in scale formation PLUS a 1% increase in yield. . . . .

Being of circular shape and having NO FORGOTTEN CORNERS AND NO COLD POCKETS, Salem Pits not only heat more ingots per square foot of occupied floor space than do the square or rectangular pits, but they also heat them MORE UNIFORMLY. Heat is obtained from a multiplicity of oil or gas burners and the hot gases enter the pit at a tangent to the circular wall of the furnace which causes the gases to follow a circular path. Thus, the hot gases are in contact with the ingots for a longer period with relatively low burner velocity. Furthermore, there is no flame impingement on the furnace wall or the steel, and all ingots are heated uniformly from top to bottom. Salem Circular Pits are built in all sizes to meet any production or building requirement. Remember, too, that the world's largest pit is of Salem design. Write today for more comprehensive facts.

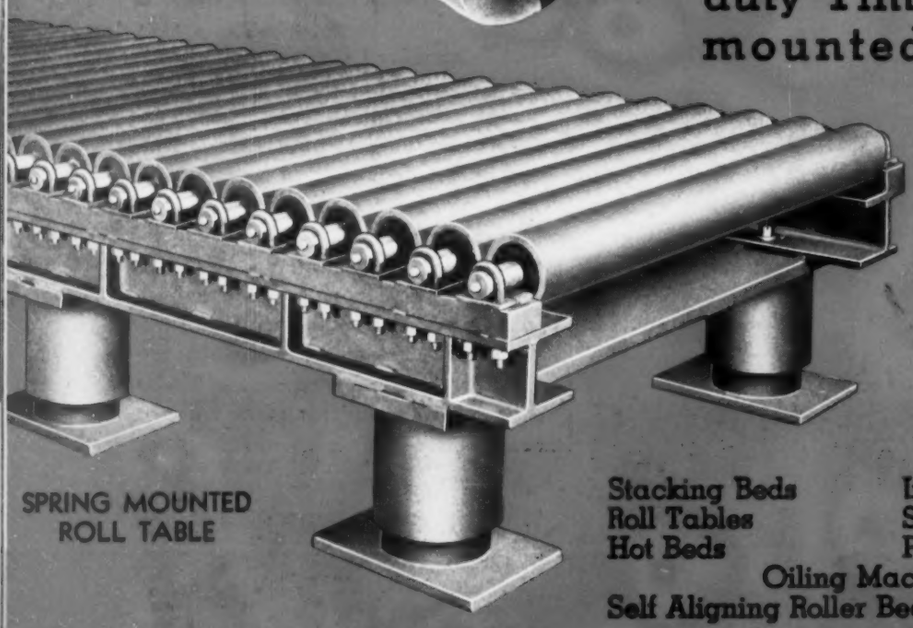
SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. • SALEM, OHIO

Spring Mounted Roll Table for Armor Plate or Coiled Strip

IMPACT *and* SHOCK CAN RETARD "PRODUCTION *for* VICTORY"

A suddenly applied load is the most destructive force encountered by Rolling Mill Conveyor Equipment. This force is met and absorbed by PALMER-BEE heavy duty Timken Roller Bearing Rolls mounted on spring supported structure. CAPACITY UP TO 15,000 LBS. PER ROLL.



SPRING MOUNTED ROLL TABLE

ENGINEERS AND BUILDERS OF STEEL MILL EQUIPMENT:

Up-enders and Down-enders
Soaking Pit Cover Lifters
Plate Turnover Rigs

Stacking Beds
Roll Tables
Hot Beds
Inspection Tables
Slab Transfers
Pilers
Tilters
Transfer Chains
Roller Conveyor
Oiling Machines
Coil Conveyors
Self Aligning Roller Bearing Pillow Blocks with Cast Steel Housings

PALMER-BEE COMPANY, DETROIT

PALMER-BEE Run-in and run-out roll tables, reversible chain transfers with 2-way shock absorbing ducking dogs, keep ARMOR PLATE rolling toward SHIPS—TANKS—TRUCKS and PLANES

Up-ender receives red hot coils and sets them on conveyor without shock.

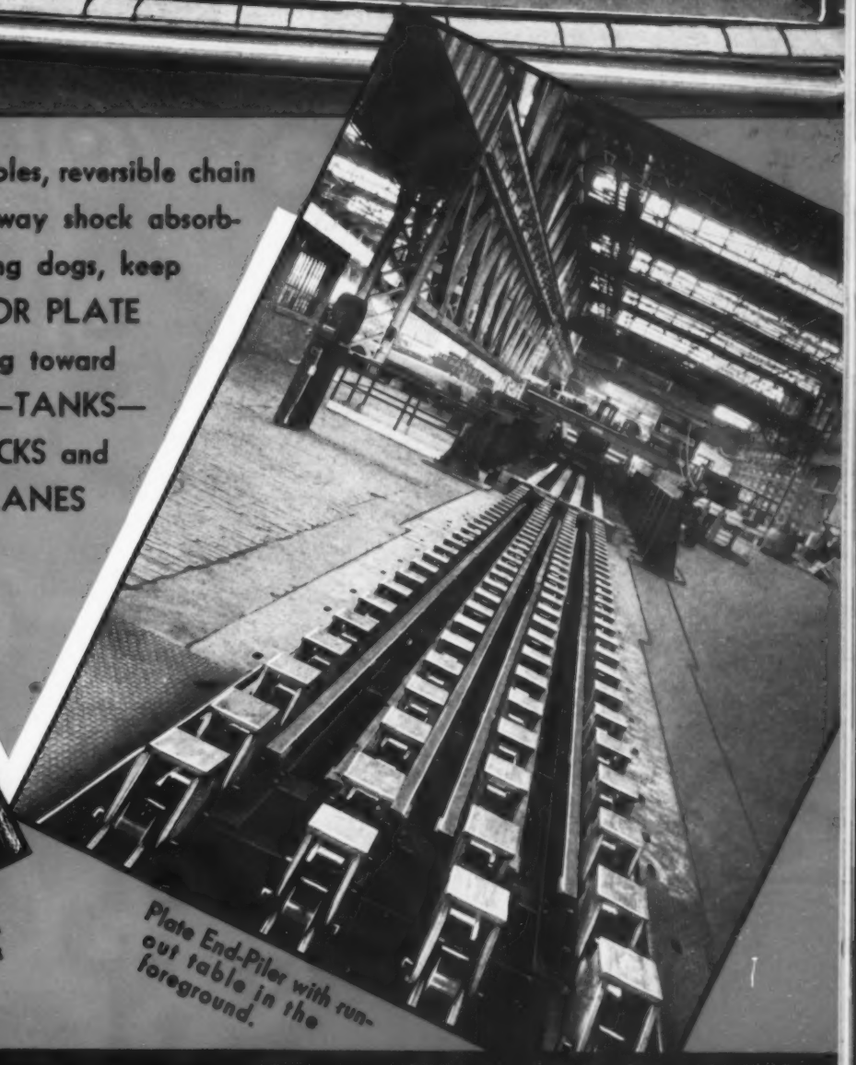
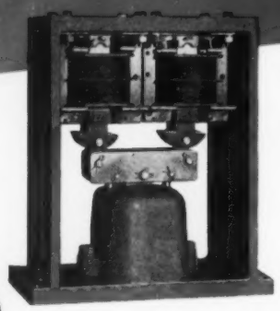


Plate End-Piler with run-out table in the foreground.

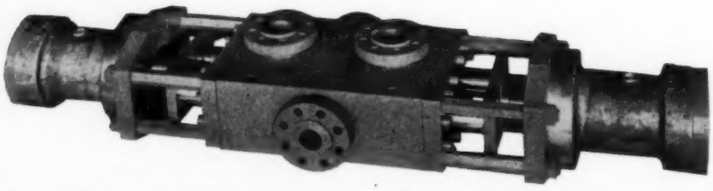
PALMER-BEE COMPANY, DETROIT

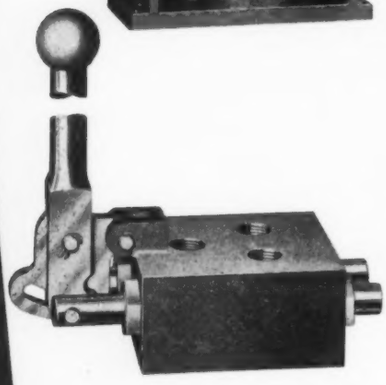
Quick-As-Wink Valves

FOR THE STEEL INDUSTRY



FOR COILERS: Solenoid-operated air valves function quickly and dependably for the control of gates, tilting tables, extractor cylinders on hot-strip coilers.





FOR ROLL BALANCE: Q. A. W. valves provide efficient and reliable control for hydraulic roll balance systems—lever-operated, 3-way, off-and-on exhaust action. Made for any pressure.

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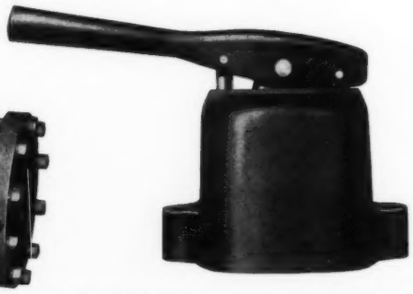

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THE MODERN *Soaking Pit* AND *Blooming Mill*

. . . . . after publication of the book, "The Modern Strip Mill", late in 1941, the editors were deluged with requests for similar information on other types of mills . . . . as a start, these data on blooming and slabbing mills are offered, in conjunction with the first meeting of the A. I. S. E. Rolling Mill Committee . . . . because of the great number of these mills, it is obviously impossible to give each installation the exhaustive analysis given the strip mills . . . . rather, it was necessary to give a summary of the composite modern mill . . . . .

by T. J. Ess

▲ AS THE primary breakdown equipment for steel ingots, blooming and slabbing mills normally work on a larger portion of the total steel production than does any other process in the steel industry. Records show that over 93 per cent of the ingot weight is rolled in blooming and slabbing mills, with the remainder going directly to plate mills, forging, etc. Yet in spite of the importance of these units in the overall processing of steel, their age is such that a considerable majority of them would be completely charged off at usual rates of depreciation. Nevertheless, these units show the results of good design, construction, and maintenance in their operating records, and are adequately roughing down the record tonnages prevailing in the industry at present.

The advent of the wide continuous strip mill, with their great demand for wide slabs, has resulted in some changes in blooming mill construction and a considerable amount of activity in this field. The increased demand for slabs could not be met by the regular blooming mill, nor by the existing universal slabbing mills. The problem was met in different ways, depending on each plant's particular requirements and the equipment at hand. Some adapted existing blooming mills by increasing the top roll lift and increasing the screwdown speed. Others installed new high-lift blooming mills or universal slabbing mills. Practically all of the installations of the last decade produce slabs, wholly or in part, and fall into three main design types, as typified by the high-lift bloomer, the conventional universal arrangement, and a modified universal arrangement with the vertical rolls placed at some distance from the horizontal rolls, all illustrated in Figure 1.

SOAKING PITS

As the first step in the rolling process is that of heating, we will first consider the blooming mill heating facilities. The heating of ingots in the soaking pit is a factor of great importance in the surface quality of the product. Poorly heated ingots may cause surface cracks and seams, rolled-in scale, etc., resulting in high conditioning costs and high rejections. Thus it is not surprising that, as quality requirements have become more stringent, we find increased attention paid to soaking pits. From the original "burying-pit," in which the ingot was placed while yet partially molten, and in which little or no fuel was burned, the soaking pit has evolved into a high grade heating furnace of good design, equipped with instruments and automatic controls.

Large heats and considerations of quality lengthened the period between pouring the ingot and charging it into the pits, so that a partial reheating became necessary. Early efforts to burn fuel in the soaking pit were crude and inefficient. Even after the early reversing, regenerative pit was developed, the heating left much to be desired. Adequate space for combustion and efficient heat transfer was lacking. The pit was not tight, and little control of the vital points of its operation was available beyond the experience and ambition of the heater. Forcing the pits became general practice in

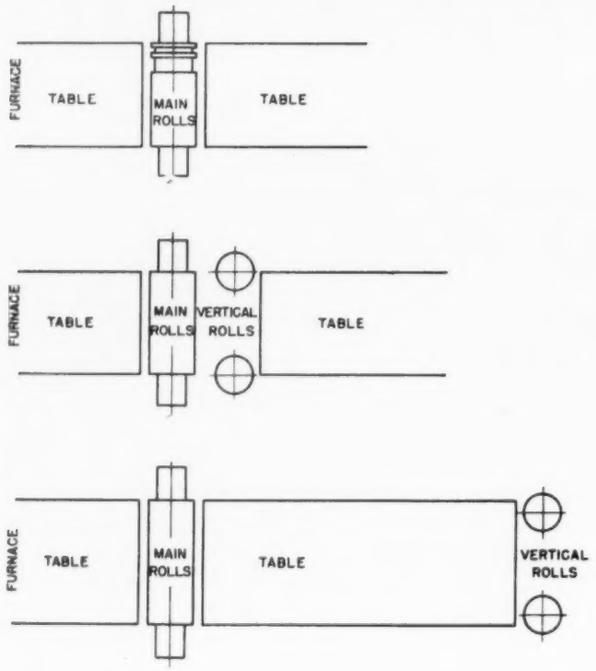


Figure 1 — Blooming and slabbing mills of recent construction follow three main design types: high-lift bloomer (top), universal (middle), or modified universal (bottom).

order to keep up with increasing mill production, and with it came marked and washed ingots. As the insistent demand for better heating continued, various improvements and new designs appeared until there evolved the efficient heating units available today.

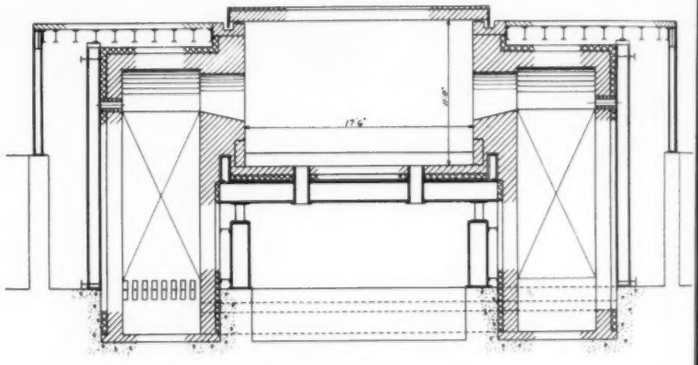
The Rust Furnace Company follows the principle of the reversing, regenerative pit, modernizing the design and adjusting their size to properly accommodate the prevailing ingot sizes. Regenerator chambers at each end of the pit contain checker work to the extent of about .75 cu ft of checkers on each end per cu ft of furnace volume if only the air is preheated. Additional checkers are added for fuel gas preheating. Combustion begins in the space above the checkerwork and continues in the pit.

New installations of reversing, regenerative pits are generally larger than their prototypes, ranging 12-17 ft in length, 8 ft 6 in. - 14 ft in width, and 9-11 ft in depth. Flat suspended covers are used, arranged with sand seals and a vertical lifting movement before opening. Thermal insulation is applied throughout.

By combining these improvements with a complete control system, the reversing pit continues to hold its place among the other designs. Each row of pits is usually equipped with a fan which supplies combustion air. Each individual hole is arranged for automatic reversal and is provided with automatic temperature, furnace pressure, and fuel-air ratio controls. Thus, each hole is operated as an entirely independent furnace. Controls are interlocked with the pit cover so that fuel valves, air valves and dampers are automatically closed when the cover opens. All operations under automatic control may be performed manually in case of control failure.

The first departure from the conventional reversing type pit was the one-way fired, recuperative pit as now built by Surface Combustion. This pit is rectangular in shape, and ranges 9-20 ft long, 5 ft 6 in. - 6 ft 5 in. wide and 10-12 ft deep. It is fired through burners located at one end near the top, the flames passing over the ingot tops, and making a U-turn to pass through the charge and out through ports located close to the pit bottom in the same end wall in which the burners are located. A recuperator, which may be installed as an integral part of the pit or in a lean-to, preheats the air for combustion. The combustion space above the ingots prevents direct flame impingement upon the ingots and makes the pits readily adaptable to all liquid and gaseous fuels. The pit cover is of flat, suspended design, is sand sealed, and carries its own operating motor. Automatic controls are applied to furnace pressure, temperature and fuel-air ratio.

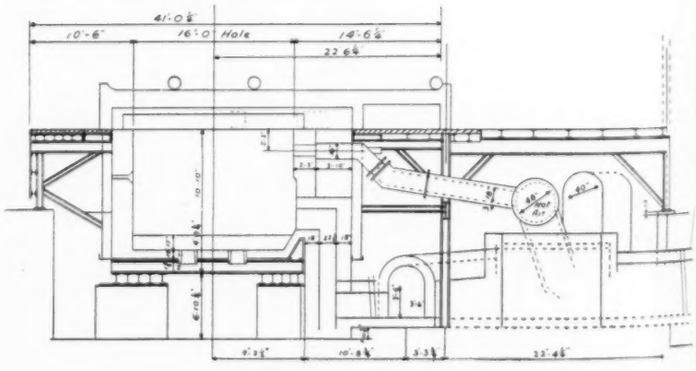
A modification of this pit has been installed in which



Figufe 2 — This reversing regenerative pit, as built by Rust Furnace Company, is designed for a rich fuel, only the air being preheated.

▲

Figure 3 — In the Surface Combustion pit the flame enters through the top of one end wall and exits through the bottom of the same wall.



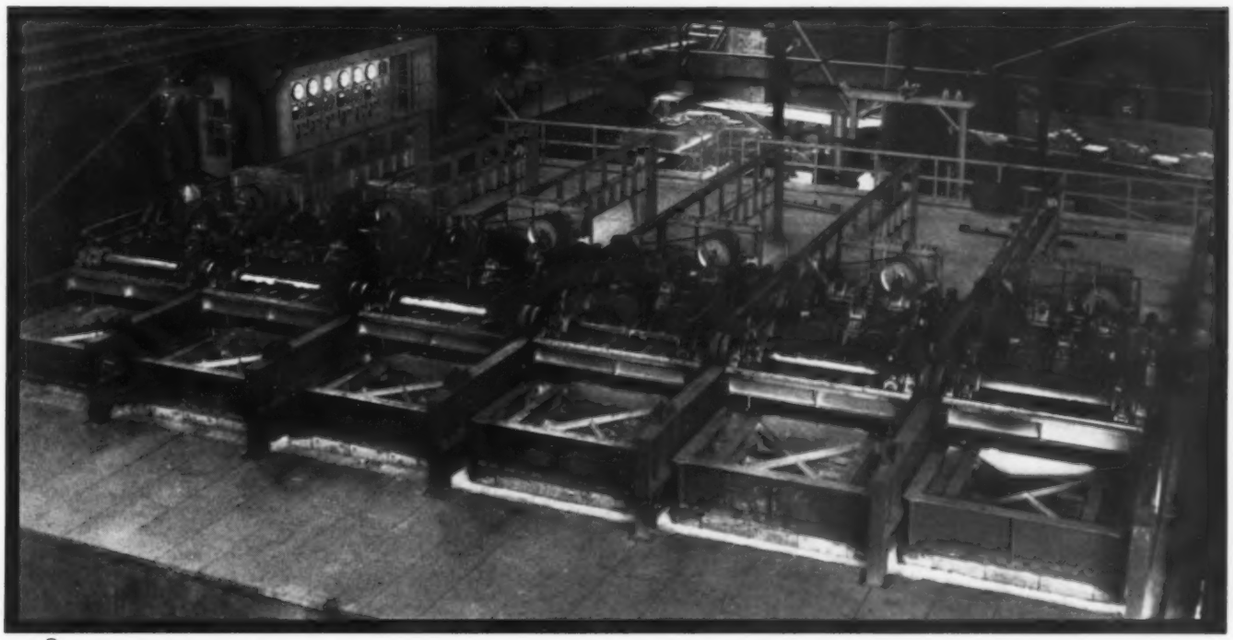
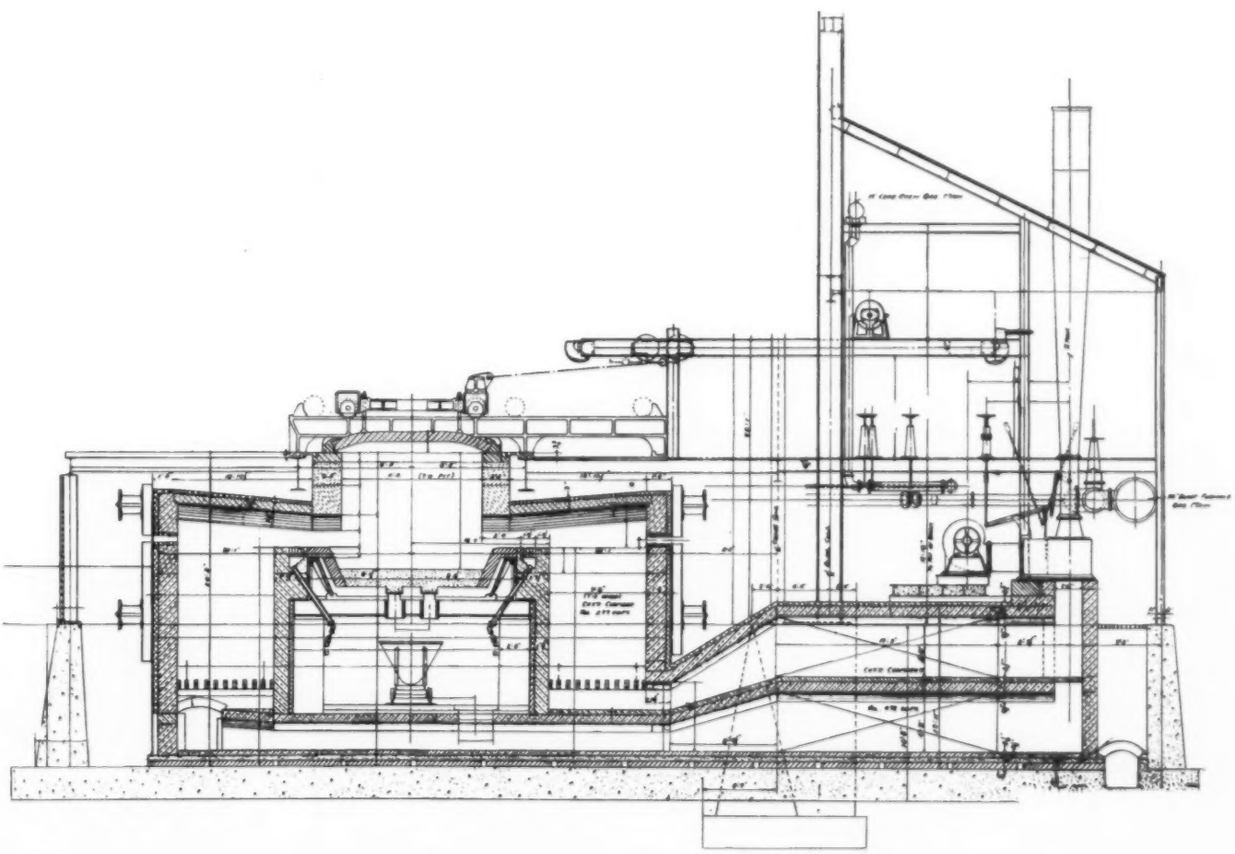


Figure 4 — (above) This modern pit installation is of the design shown in Figure 3.

Figure 5 — (below) Section showing installation of reversing, regenerative pits built with the Isley control system.



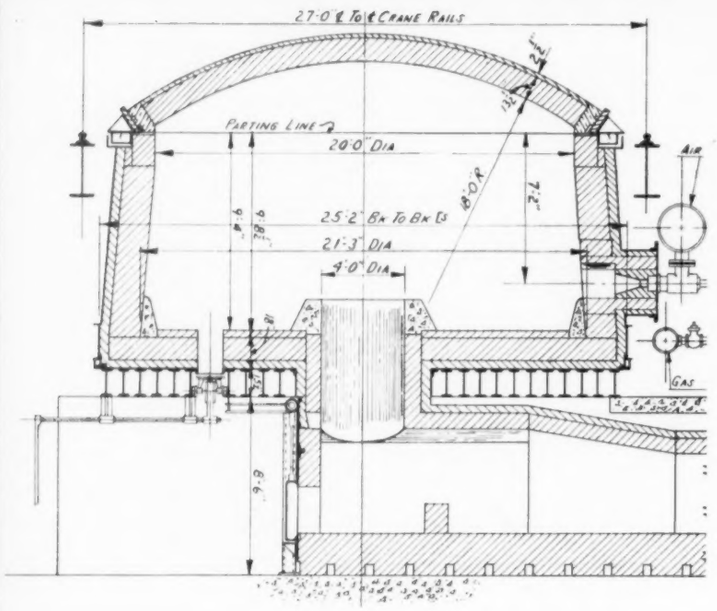


Figure 6 — The circular pit of Salem Engineering Company is fired through burners spaced around the circumference near the bottom.

firing is accomplished simultaneously from two ends. There are a burner and a flue in each end wall, at the diagonal corners, so as to give improved heat distribution over a wide range of firing rates.

The Isley design, built by Morgan Construction Company, is not a type of pit, but rather a control system applied to the reversing, regenerative pit. The system is based on two main features. By adding horizontal flue checker chambers to the conventional regenerative system, higher preheat is obtained for the combustion air. To overcome the added resistance of these checkers, and to afford flexible control of furnace pressure, a draft unit is installed at each end of the system, alternately acting to produce forced and induced draft as the furnace is reversed. The draft unit is usually a blower which forces cold air through a nozzle located in the base of the short ejector stack. This ejector is equipped with a damper which slides across the throat. When this damper is closed, cold air passes down around the nozzle and is pushed through the checkerwork and into the pit. When the damper is open, the jet of cold air from the nozzle acts to entrain the waste gases from the pit, pulling them out through the ejector throat. A blower and ejector stack is provided for each end of the pit. In this construction, the various valves and dampers comprising the usual reversing mechanism are eliminated, and the velocity and volume of the air for combustion and for producing the draft are controllable at all times.

The circular pit, manufactured by the Salem Engineering Company, is non-reversing, direct fired through premixing or nozzle mixing burners spaced around the pit circumference near the bottom. Pits of this type have been built ranging 10-20 ft in diameter and 7-10 ft in depth, all steel-encased. In a typical 16 ft pit of the original design, 12 burners were used, firing through 15 in. circular ports at an angle of about 37 degrees with the radius, thus giving a mixing action to the gases within the pit. The diameter of the pit at the bottom was 20 ft 9 in. A bridge wall about 15 in. high was located 18 in. in front of the burner ports. In the more recent designs the bridge wall is eliminated, and the side walls are brought all the way down to the bottom as shown in Figure 6, without the previous "lean-to" effect. In some cases the burners may be

Figure 7 — This view shows part of an installation of pits totaling 2,000,000 tons annual capacity. The pits are of the design shown in Figure 8.

applied firing in a direct radial direction instead of at an angle. Waste gases leave the pit through a single center off-take about 4 ft in diameter, which is connected to a stack through a flue. The pit cover, which is dome-shaped and of lift type with sand seal, is handled by a stiff-leg traveling crane mechanism. Automatic controls are usually applied to furnace pressure, fuel-air ratio, and temperature. Installations of these pits have generally used no recuperation, claiming to offset this loss by the exact fuel-air proportioning obtained, although recuperators may be applied. One installation passes the exit gases from the pits through waste heat boilers.

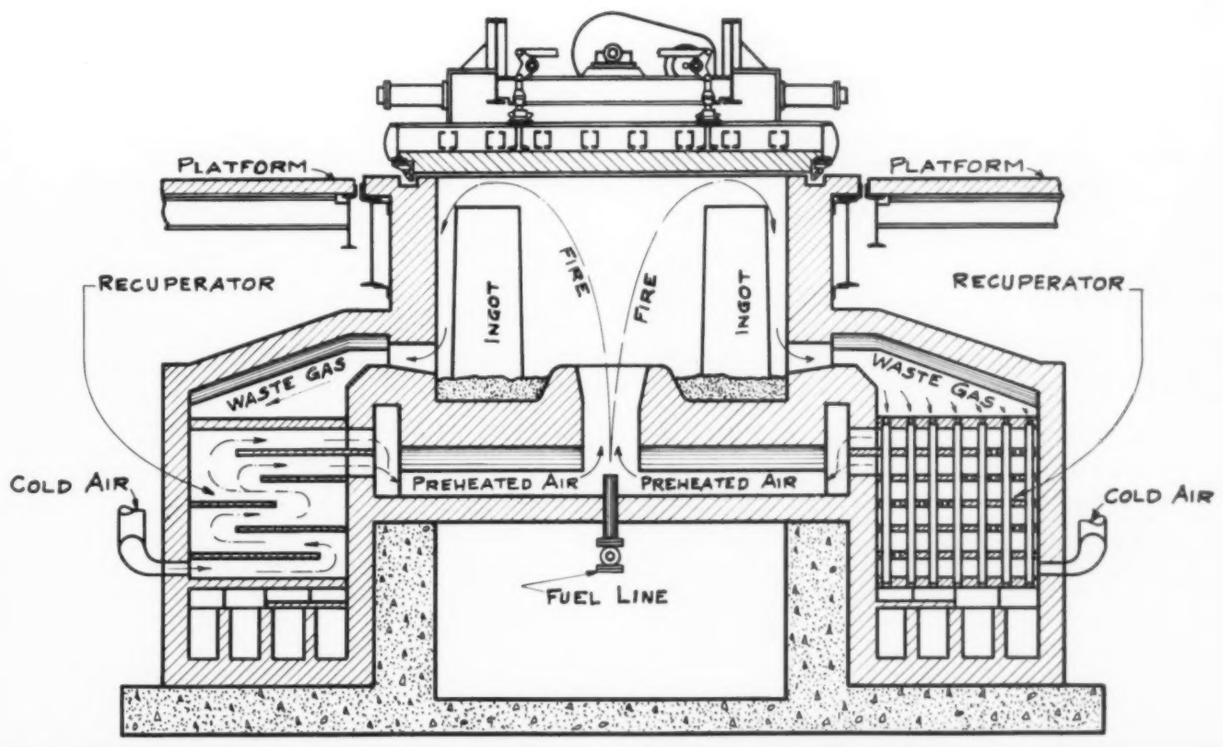
The Amsler-Morton pit is non-reversing, direct fired from a single dry pipe burner through a circular bottom port about 3 ft in diameter in the center of the bottom, the top of the port extending 19 in. above the pit bottom or about 5 in. above the coke bed. The pit is rectangular in shape, ranging 10 ft 6 in.-20 ft in length, 8 ft 9 in.-16 ft in width and 8-15 ft deep. The pit is steel-encased with walls of 18 in. of refractory + 4½ in. of insulation, and has a flat, suspended cover. The pit bottom, which is 13 in. of refractory + 2½ in. of insulation supported on structural work, contains four clean-out holes. A coke bed of 12-16 in. depth is usual. Waste gases are removed through outlets near the four corners, just above the coke bed, and pass on to four separate recuperators set symmetrically in relation to the pit. The recuperators consist of octagonal sectional tubes of thin-wall refractory with horizontal joints, and total a volume of .53-.80 cu ft per cu ft of furnace volume.

Recuperator walls are steel-encased, 9 in. of firebrick + 4½ in. of insulation. Covers are 9 in. of brick + 2 in. of insulation. Waste gases pass down through the tubes and into collecting ducts leading to the stack. Air enters at the recuperator base through manually set slide gates and passes through baffles to give five passes as it rises to the top of the recuperator outlet and on to the burner port. Waste gas ducts pass below the recuperators and extend to the stack in round steel refractory lined flues. Two flues from the pit join to a common 37 in. diameter uptake, containing an automatically controlled butterfly damper and a manual mushroom damper, and leading to a stack about 100 ft high.

The pit design of Swindell-Dressler Corporation, as shown by installations to date, is a rectangular pit ranging 16-22 ft long, 14-16 ft wide and 9-11 ft deep above a 12-16 in. coke bed, although other sizes may be built. The pit is fired through two gas or oil (or combination) burners placed in the opposite end walls, 3 ft above the coke bed and directly opposed to each other. Four exit ports placed in the end walls near the corners, 5-12 in. above the coke bed, draw off waste gases, which pass through four silicon carbide tubular recuperators, one at each corner of the pit. Side walls of the pit are 18 in. of firebrick +4½ in. of insulation, completely encased in steel plate. Bottoms consist of 13 in. of firebrick +4½ in. of insulation. A single fan pushes combustion air through the recuperators and forces it on to the two low pressure burners, which are of an adjustable long flame type and usually operated with highly luminous flames so that the two flames meet in the approximate center of the pit. The burners have a high capacity, which, with the mixing given by their opposed action, means a high rate of heat release in the pit. The pit is fully automatic, being equipped with temperature control, furnace pressure control and fuel-air ratio control.

In the modern installations, with the larger pits, complete automatic control is usually installed. Heat input regulation, or temperature control, is probably the most important feature, and not the least difficult. The fact that the control point is up to temperature is not an indication that the steel itself is properly heated. Rather, it is necessary that, when the control point is

Figure 8 — The Amsler-Morton design, another one-way recuperative pit, is fired through a single burner in the middle of the pit bottom.



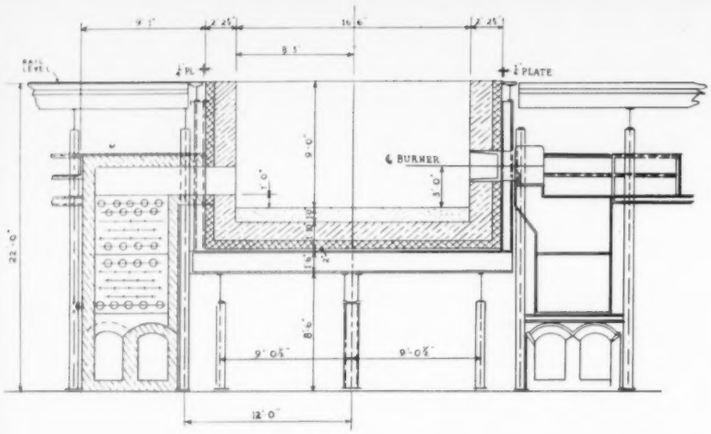


Figure 9 — The Swindell-Dressler recuperative pit is fired through each end wall as shown in the right-hand section and exhausts through two ports in each end wall as indicated in the left-hand section.

up to temperature, the fuel input be gradually reduced until input becomes constant at a value corresponding to radiation and stack losses, at which point the steel may be assumed to be uniformly heated.

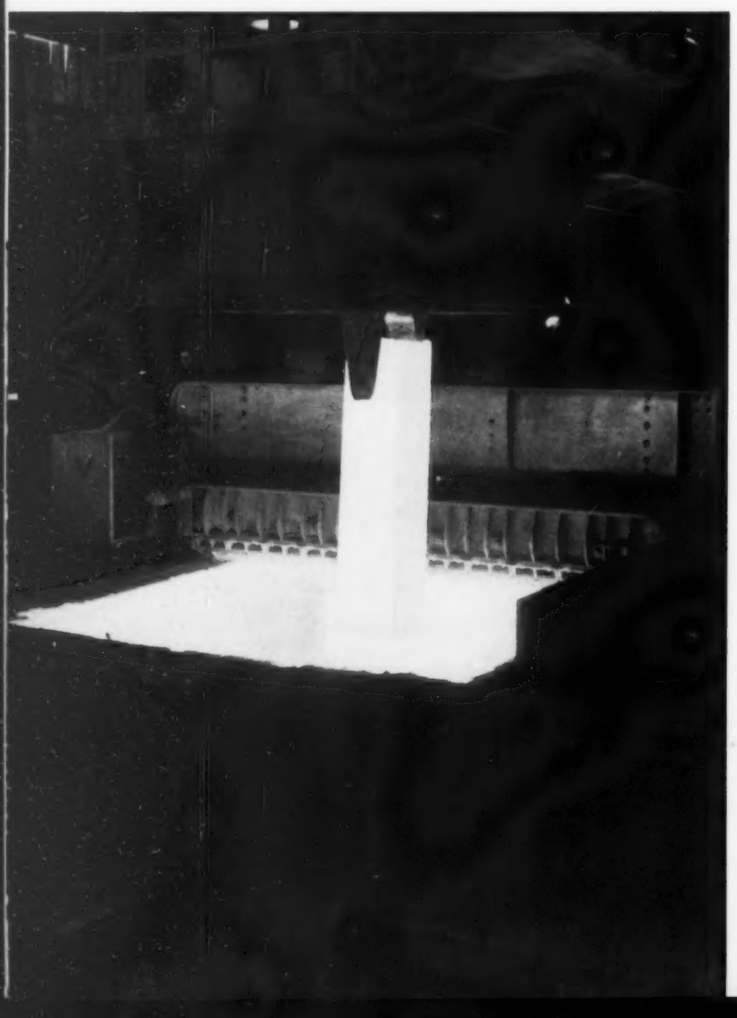
The advantage of fuel-air ratio control is obvious to anyone acquainted with the principles of combustion. Any automatic control, however, must be arranged so that manual adjustments can be made. The fuel-air ratio should not be necessarily constant at all firing rates, as it must be changed sometimes in order to effectively control furnace atmosphere. With a heavily reducing atmosphere, the scale on the ingot tends to be thin and tight, adhering to the ingot and rolling into the steel in the rolling operation. With a more oxidizing atmosphere the scale is loose and porous, and is knocked off the ingot in the first passes in the mill, resulting in a better surface on the bloom or slab.

Likewise, furnace pressure control is desirous from the standpoint of furnace atmosphere, as well as uniformity of temperature distribution. Pressure regulation prevents air infiltration at reduced rates of firing, as well as a short-circuiting action of the gases in the pit which might result in localized heating. Pressure regulation does not necessarily mean maintaining a constant furnace pressure. Rather, the furnace pressure should be adjusted so as to produce the desired heating effect on all ingots in the pit.

Control application to soaking pits may vary widely with the pit design and the nature of the fuel. Figures 11 and 12 illustrate typical control for one-way firing and reversing practice with a stable gaseous fuel. If the fuel varies in heat value, a Btu meter may be used to load the fuel-air ratio regulator in accordance with fuel fluctuations. The controls may be suitably applied and arranged to meet the various conditions offered by various fuel or other plant conditions.

According to the latest available figures there are about 2250 soaking pits in the steel plants of the United States. Of these, about 1800 are of old design and comparatively small size, holding four to eight ingots and having a heating capacity of 1500-3000 tons per month. There are approximately 450 pits of improved design, of which about 320 use one-way firing. Recent programs for new pits are gradually improving this condition.

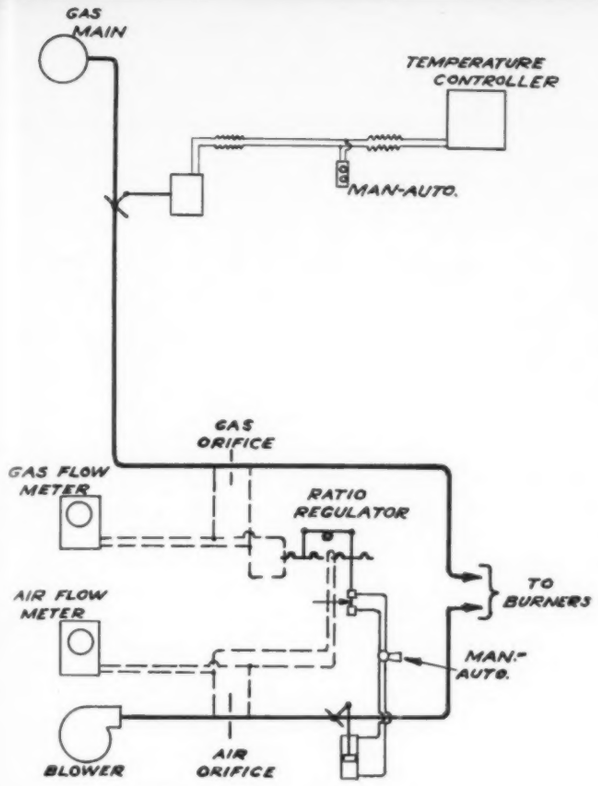
Figure 10 — The gradual tightening of steel quality requirements has resulted in considerable activity in the installation of modern soaking pits.



The temperature to which ingots are heated in the pits depends on steel analysis, and varies with the carbon content approximately as shown in Figure 13.

The heating capacity of soaking pits depends on their design and loading, the ingot size, the temperature of pit and ingot when charged, the kind of fuel and the rate of fuel input. Pit loading materially influences heating time. If pits are overloaded it is difficult to thoroughly heat all the ingots in the pit, and the time required to bring the entire charge up to temperature is greater than with a nominal charge. Modern practice seems to show a total hearth area of about 1.1-2.5 sq ft per ton of ingots charged, depending on ingot size.

The time required to heat ingots in the soaking pit depends materially upon the temperature of the ingots charged. It is general practice to charge ingots into the soaking pits before the steel has cooled much below the temperature of solidification. This is preferable because it avoids the internal stresses set up by both the cooling to atmospheric temperature and the subsequent reheating. Such stresses are caused by unequalized forces of contraction and expansion in different parts of the ingot, and may cause cracks that will not be eradicated by the rolling. Cold ingots should not be charged into hot pits, particularly if of a "tender" analysis or type. The pits should be cooled to within a few hundred degrees of the ingot temperature in order to keep skin cracking to a minimum. Good practice seems to call for retarded heating until the "blue-brittle" range (about 700 F) is passed, when heating may be speeded up and



Figures 11 and 12 — Diagrams showing typical control applications to one-way pit (above), and to reversing pit (below).

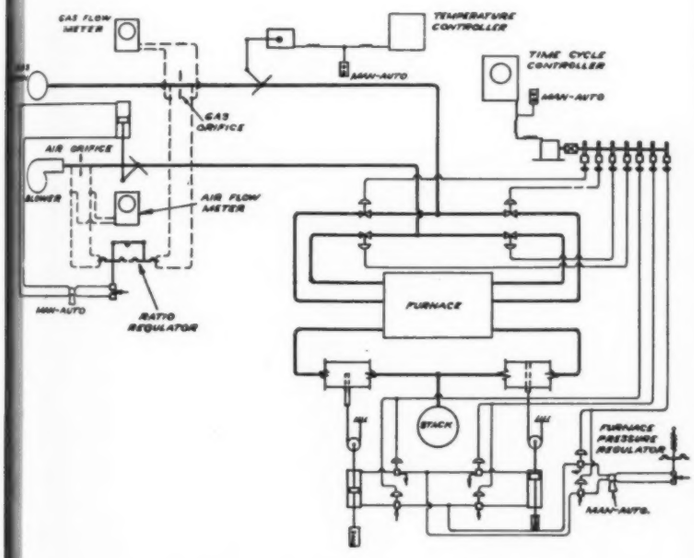
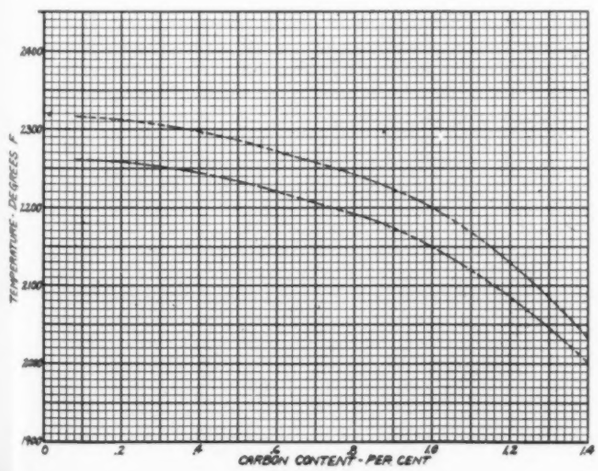


Figure 13 — (below) Usual temperatures for rolling steel vary with the carbon content as indicated by these curves.



perhaps alternated with soaking periods. Approximately 8-10 per cent of the total production is charged cold to the pits. When hot steel is charged, the pits need not be cooled to any great extent, and heating may be more rapid.

The time requirements for heating are complicated by the ability to push the pits without marking the ingots, and by an unassessable human element. Thus, it may be possible to heat a single ingot in a forge furnace in 3-4 hr, while it may require twice that time to bring up a pit full of the same ingots. The human element enters through the caution of individuals who may have experienced trouble and desire to be doubly sure to avoid it in the future, accordingly heating at abnormally slow rates. There are also cases where a lengthening of heating time is applied as a cure for every dose of trouble encountered. It is necessary to use reason in such cases, even though it is admitted that soaking pit heating (and the subsequent rolling) are critical operations in the control of quality of the product. A good jacket of scale and a uniform temperature without cracking are absolutely essential. If these ends are attained, the rate of heating is of little consequence.

Some general rules may be laid down which must be used with caution. Hot ingots can generally be brought up to temperature in about the same time as has elapsed between pouring the ingot and charging it into the pits. In practice, somewhat more heating time is taken, inasmuch as the average delivery time for the industry is about 2 hr, while the heating time ranges 2-4 hr with a regular flow of hot ingots. One plant uses 1½ times the delivery time, while another plant allows delivery time plus one hour. Still another plant imposes a minimum of 3 hr time in the soaking pits. Cold ingots of plain low carbon steel, 20-24 in. in size can be satisfactorily heated in 6-8 hr, or 15-20 min per in. of thickness. This time can be reduced if the pits are not charged too heavily, but at some sacrifice in uniformity of temperature. Some operators believe that 12 hr should be allowed to bring cold 24 in. ingots up to temperature.

Figure 14 gives heating periods for ingots of various size, and for varying delivery (or track) time. These values are derived from a wide field of sources, data from which varies considerably. Hence, the chart is made up as a series of ranges or bands. The shaded area is the range of heating times for cold steel, and acts as a limit for the horizontal bands representing the different track times. The figures advanced by the chart may be considered fairly representative of general practice although some plants prefer even slower heating. Table I gives slower heating rates as recommended by one plant for 24 in. ingots at various temperatures, and also includes fuel consumptions and production rates.

It will be noted from Table I that the heating rate varies from 82 lb per hr per sq ft of hearth for cold steel to 189 lb per hr per sq ft for very hot steel. One manufacturer uses a rating of 70 lb per hr per sq ft for cold steel and 170 lb per hr per sq ft for hot steel. Many cases are on record of hot ingots being heated at rates of 200-360 lb per hr per sq ft, and cold ingots are heated at rates in excess of 100 lb per hr per sq ft. Because of the fact that the flow of ingots to the pits is not regular, the production figure in practice may fall between 90 and 140 lb per hr per sq ft of hearth area. In checking

TABLE I — Heating Time for 24 in. Ingot

Surface temperature of ingot, F.	1800	1625	1200	900	Cold
Average temperature of ingot, F.	2025	1850	1425	1150	. . . . .
Heating time, hr.	4	5	6.5	8.0	9.5
Fuel consumption, Btu per net ton.	235,000	324,000	530,000	824,000	1,350,000
Production, lb per hr per sq ft.	189	151	116	94.5	82

through a number of plants, total soaking pit hearth areas are found ranging from 1300 sq ft to 3850 sq ft per mill, or about 20-25 sq ft per ton of ingots rolled per hr. This would indicate an overall productive rate of 80-100 lb per hr per sq ft of hearth area. Throughout the industry, the general complaint is a shortage of soaking pit capacity, although some few plants will admit having a sufficiency.

For continuity of operation, pit capacity must equal the mill rolling rate × the heating time. The size of each pit must be based on the size of the ingots and their arrangement in the pit to obtain good heating. If only one ingot size were used in a plant, the pits could be closely designed to cover and heat these ingots in proportion to the mill output. This is seldom the case, however. Several sizes of ingots are generally used, with the rolling rate and the pit capacity varying for each size. A detailed analysis is therefore necessary, considering each condition, and the decision is often a compromise. In some cases, it is considered desirable to install pits of various size. Some mill operators do not favor this, but want pits of uniform size. Some operators favor the medium size pit over the large pit, feeling that ingots in the large pits become chilled through many openings of the cover. The arrangement of ingots in the pit should be such as to keep direct flame impingement to a minimum.

In any comparison of soaking pit operation and performance, the rate of heating of cold ingots is probably the logical basis. The term "hot ingots" is so elastic as

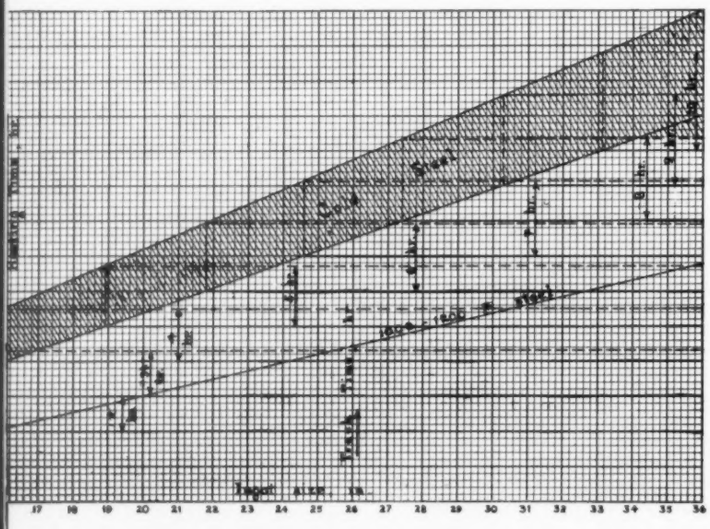


Figure 14 — Chart showing approximate heating time for various ingot sizes and for various track times.

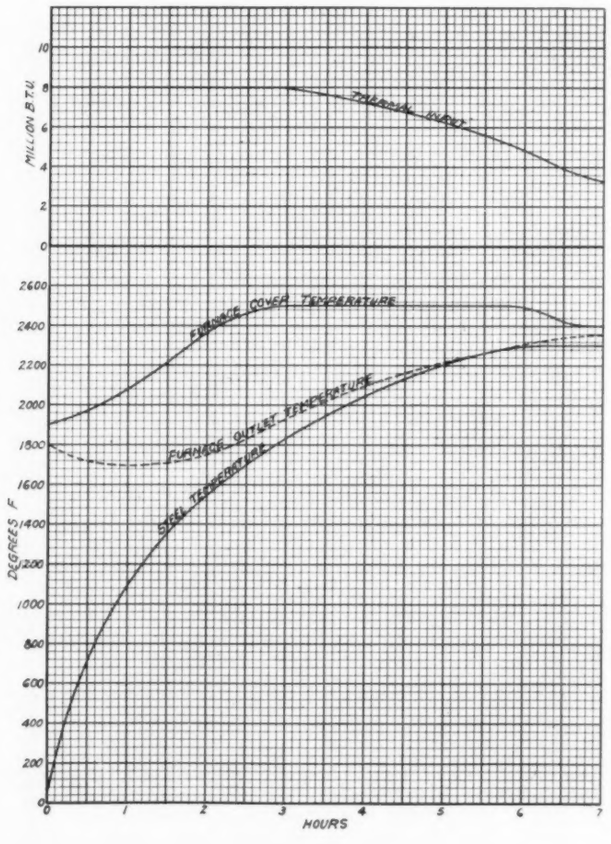


Figure 15 — Chart showing typical heating cycle under automatic temperature control.

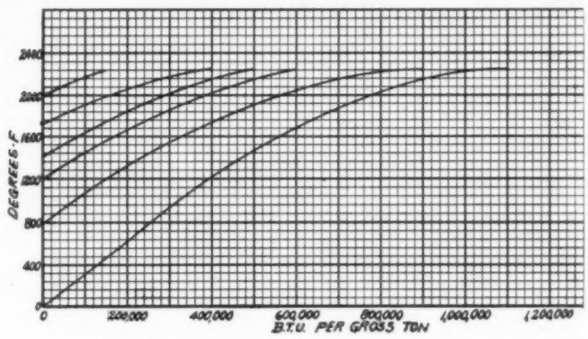


Figure 16 — Fuel consumption in the soaking pit depends largely upon temperature of the charged ingots, as indicated here.

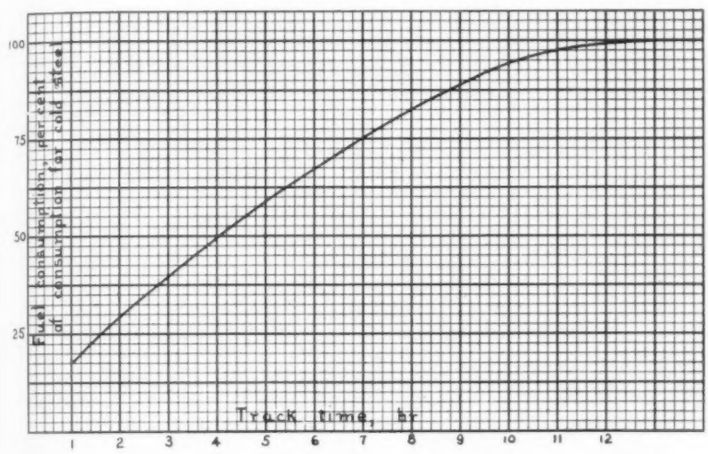


Figure 17 — This curve shows the variation of fuel consumption with respect to track time.

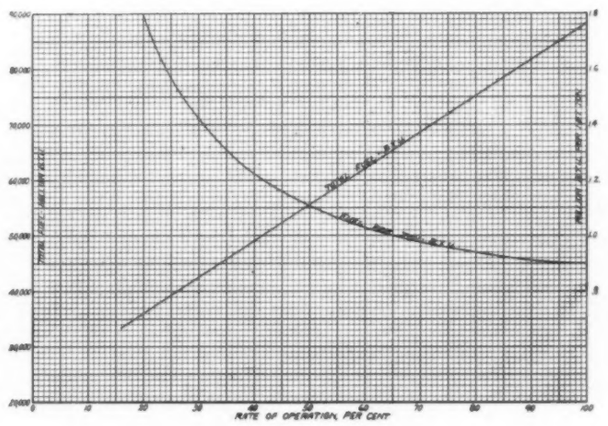


Figure 18 — Fuel consumption of soaking pits also varies widely with the steadiness of operation.

to be almost meaningless. Another point which must be considered is the uniformity of heating throughout the pit and throughout the length of the ingot.

Rich fuels normally give faster heating than the leaner fuels, and, as might be expected, a high rate of fuel input results in faster heating. With thin-skinned, high carbon, or alloy ingots, however, it is often necessary to heat at rates more moderate than can safely be used with rimmed or low carbon ingots, if surface difficulties are to be kept to a minimum. Fuel inputs in modern pits range 1600-14,000 Btu per hr per cu ft of furnace volume, with an average on the order of 4000-5000. In the modern installations with automatic control, fuel input is automatically reduced as the furnace temperature comes up to the desired point, resulting in a heating cycle as shown in Figure 15.

Almost every type of gaseous fuel is used in the soaking pits of the country, as well as some fuel oil. Coke oven gas and producer gas seem to be more favored, with a goodly number of mixed gas applications using blast furnace gas mixed with coke oven or natural gas. There are also a number of installations using straight blast furnace gas, straight natural gas, or fuel oil. It may be stated that, in general, the lean fuels (100-150 Btu per cu ft) are best suited to regeneration, and the richer fuels to the recuperative type of pit, although either kind of pit may be designed for any fuel. As noted in the previous descriptions of pit designs, the fuel is applied to the pit in various ways.

Fuel consumption of soaking pits is highly variable, depending principally on the temperature of the ingots charged. The effect of initial ingot temperature is shown by the curves of Figure 16, while Figure 17 gives the effect of various track times. These figures are for a modern, efficient pit and are base rates, not including fuel for holding, heating up, etc. The overall average fuel rate for the country is considerably higher than the figures shown in the curves, being estimated at about 1,250,000 Btu per ton in spite of the fact that

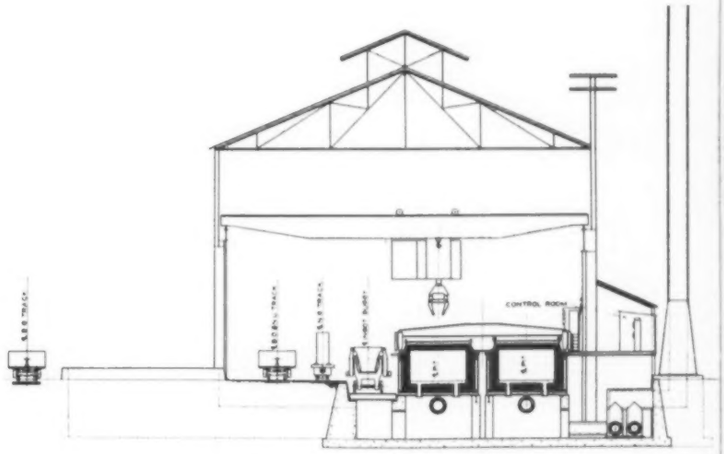


Figure 19 — Sectional drawing showing typical arrangement of soaking pit installation.

TABLE II — Blooming and Slabbing Mills

(This list does not include all of the breakdown units incorporated into intermediate mills.)

Company	*Plant*	*Size, in.*	*Type*	*Motor hp*	*Motor rpm*	*Motor voltage*
Alan Wood Steel Co.	Ivy Rock, Pa.	35	2-high, reversing	.....	.....	.....
Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	34	2-high, reversing	.....	.....	.....
American Rolling Mill Co.	Ashland, Ky.	40	2-high, reversing	3250	50/120	600
	Butler, Pa.	38	2-high, reversing	7000	50/120	700
	Middletown, Pa.	45 (s)	2-high, reversing	(2) 5000	40/80	700
				2000	100/200	700
American Steel & Wire Co.	Donora, Pa.	40	2-high, reversing	.....	.....	.....
	Duluth, Minn.	40	2-high, reversing	.....	.....	.....
	Worcester, Mass.	34	2-high, reversing	.....	.....	.....
Andrews Steel Co.	Newport, Ky.	36	2-high, reversing	.....	.....	.....
Atlantic Steel Co.	Atlanta, Ga.	25	2-high, reversing	2200	70/150	600
Bethlehem Steel Co.	Bethlehem, Pa.	40	2-high, reversing	.....	.....	.....
	Bethlehem, Pa.	40	2-high, reversing	.....	.....	.....
	Bethlehem, Pa.	46	2-high, reversing	.....	.....	.....
	Bethlehem, Pa.	35	2-high, reversing	3600	40/90	600
	Steelton, Pa.	44	2-high, reversing	6000	40/120	600
	Sparrows Point, Md.	46	2-high, reversing	7000	50/100	650
	Sparrows Point, Md.	40	2-high, reversing	6500	50/120	600
	Sparrows Point, Md.	40 (s)	2-high, reversing	7000	50/100	650
				2500	100/300	650
	Lackawanna, N. Y.	40	2-high, reversing	7000	50/120	700
	Lackawanna, N. Y.	44	2-high, reversing	7000	50/120	750
	Lackawanna, N. Y.	54	2-high, reversing	7000	40/80	750
	Johnstown, Pa.	48	2-high, reversing	.....	.....	.....
	Johnstown, Pa.	40	2-high, reversing	5000	75/150	700
	Johnstown, Pa.	34 (s)	2-high, reversing	.....	.....	.....
A. M. Byers Co.	Ambridge, Pa.	40	2-high, reversing	5000	50/130	900
Carnegie-Illinois Steel Corp.	Clairton, Pa.	40	2-high, reversing	.....	.....	.....
	Duquesne, Pa.	40	2-high, reversing	.....	.....	.....
	Duquesne, Pa.	38	2-high, reversing	.....	.....	.....
	Braddock, Pa.	45 (s)	2-high, reversing	(2) 5000	40/80	700
				3000	60/180	700
	Braddock, Pa.	48	2-high, 2 stands	.....	.....	.....
	Braddock, Pa.	40	3-high	.....	.....	.....
	Farrell, Pa.	36	2-high, reversing	.....	.....	.....
	Homestead, Pa.	44	2-high, reversing	7000	50/120	700
	Homestead, Pa.	54	2-high, reversing	8000	40/80	700
	Homestead, Pa.	30 (s)	2-high, reversing	.....	.....	.....
	Homestead, Pa.	32 (s)	4-high	.....	.....	.....
	Youngstown, O.	43	3-high	.....	.....	.....
	Youngstown, O.	40	2-high, reversing	.....	.....	.....
	Gary, Ind.	44	2-high, reversing	8000	40/100	800
	Gary, Ind.	40	2-high, reversing	6000	40/90	600
	Gary, Ind.	36 (s)	2-high, reversing	.....	.....	.....
	Gary, Ind.	40	2-high, 4 stands	(2) 2000	214	6600
	Gary, Ind.	32	2-high, 5 stands	6000	83	6600
	Gary, Ind.	40	2-high, 4 stands	(2) 2000	214	6600
	Gary, Ind.	40	3-high, 1 stand	6000	75	6600
	South Chicago, Ill.	54	2-high, reversing	(2) 5000	40/80	700
	South Chicago, Ill.	40	2-high, reversing	7000	40/120	700
	South Chicago, Ill.	40	2-high, reversing	7000	50/120	750
	South Chicago, Ill.	35	2-high, reversing	6500	60/140	700
	South Chicago, Ill.	44 (s)	2-high, reversing	(2) 5000	40/80	600
				2500	.....	.....
	Vandergrift, Pa.	35	2-high, reversing	.....	.....	.....
Carpenter Steel Co.	Reading, Pa.	22	3-high, 3 stands	.....	.....	.....
Colonial Steel Co.	Colona, Pa.	24	2-high	.....	.....	.....
Colorado Fuel & Iron Co.	Pueblo, Col.	40	2-high, reversing	.....	.....	.....
	Pueblo, Col.	36	2-high, reversing	.....	.....	.....
Columbia Steel Co.	Pittsburg, Cal.	26	3-high	.....	.....	.....
	Torrance, Cal.	36	3-high	.....	.....	.....
	Torrance, Cal.	36	3-high	.....	.....	.....
Continental Steel Corp.	Kokomo, Ind.	34	2-high, reversing	3500	50/120	700
Copperweld Steel Co.	Warren, O.	29	3-high	2000	.....	.....
Crucible Steel Co. of America	Syracuse, N. Y.	28	3-high	.....	.....	.....
	Pittsburgh, Pa.	34	2-high, reversing	.....	.....	.....
Empire Sheet & Tinplate Co.	Mansfield, O.	32	3-high	2000	240	2200
Ford Motor Co.	Dearborn, Mich.	44	2-high, reversing	7000	50/120	750
	Dearborn, Mich.	42-32	2-high, 8 stands	8000	240	13200
Granite City Steel Co.	Granite City, Ill.	34	2-high, reversing	.....	.....	.....
	Granite City, Ill.	100 (s)	2-high, reversing	.....	.....	.....
Great Lakes Steel Corp.	Ecorse, Mich.	46	2-high, reversing	7000	40/100	700
	Ecorse, Mich.	40	2-high, reversing	7000	50/120	770
Harrisburg Steel Co.	Harrisburg, Pa.	32	2-high, reversing	.....	.....	.....
Inland Steel Co.	Indiana Harbor, Ind.	46	2-high, reversing	7000	50/120	700
	Indiana Harbor, Ind.	40	2-high, reversing	6500	40/120	600
	Indiana Harbor, Ind.	36	2-high, reversing	7000	50/120	700
International Harvester Co.	South Chicago, Ill.	40	2-high, reversing	7000	50/120	700
	South Chicago, Ill.	32	2-high, reversing	4000	75/165	700
Jessop Steel Co.	Washington, Pa.	26	2-high, reversing	.....	.....	.....
Jones & Laughlin Steel Corp.	Aliquippa, Pa.	44	2-high, reversing	.....	.....	.....
	Pittsburgh, Pa.	44	2-high, reversing	7000	50/120	750
	Pittsburgh, Pa.	44	2-high, reversing	.....	.....	.....
	Cleveland, O.	40	2-high, reversing	6500	50/120	600
Keystone Steel & Wire Co.	Peoria, Ill.	34	2-high, reversing	3250	50/120	600
Laclede Steel Co.	Alton, Ill.	32	2-high, reversing	.....	.....	.....
National Tube Co.	McKeesport, Pa.	40	2-high, reversing	.....	.....	.....
	McKeesport, Pa.	40	2-high, reversing	.....	.....	.....
	Lorain, O.	38	2-high, reversing	.....	.....	.....
	Lorain, O.	38	2-high, reversing	.....	.....	.....
	Lorain, O.	40	2-high, reversing	5000	40/120	600
Northwestern Steel & Wire Co.	Sterling, Ill.	22	3-high, 2 stands	.....	.....	.....
Phoenix Iron Co.	Phoenixville, Pa.	36	2-high, reversing	3500	50/120	700
Pittsburgh Crucible Steel Co.	Midland, Pa.	40	2-high, reversing	5000	60/120	750
Pittsburgh Steel Co.	Monessen, Pa.	46	3-high	.....	.....	.....
Republic Steel Corp.	Youngstown, O.	40	2-high, reversing	.....	.....	.....
	Youngstown, O.	40	2-high, reversing	.....	.....	.....
	Warren, O.	36	2-high, reversing	6500	50/120	600
	Canton, O.	35	2-high, reversing	5000	40/120	600
	Canton, O.	34	2-high, reversing	3750	50/130	700
	Massillon, O.	34	2-high, reversing	3500	50/75	700
	Buffalo, N. Y.	38	2-high, reversing	4000	58/120	750
	South Chicago, Ill.	34	3-high	4000	58/140	750
	Cleveland, O.	44	2-high, reversing	.....	.....	.....
	Cleveland, O.	36	2-high, reversing	4000	60/140	900
	Gadsden, Ala.	40	2-high, reversing	7000	50/120	700
Roebling's Sons Co.	Roebling, N. J.	35	3-high	.....	.....	.....
Rotary Electric Steel Co.	Detroit, Mich.	28	2-high, reversing	1500	60/120	600
Rustless Iron & Steel Corp.	Baltimore, Md.	20	3-high, 3 stands	.....	.....	.....
Sharon Steel Corp.	Lowellville, O.	34	2-high, reversing	3500	50/120	700
Sheffield Steel Corp.	Sand Springs, Okla.	24	3-high	.....	.....	.....
Simonds Saw & Steel Co.	Lockport, N. Y.	24	2-high	.....	.....	.....
Stanley Works	Bridgeport, Conn.	34	2-high	.....	.....	.....
Tennessee Coal, Iron & Railroad Co.	Ensley, Ala.	44	2-high, reversing	.....	.....	.....
	Fairfield, Ala.	45	2-high, reversing	7000	55	900
	Fairfield, Ala.	46	2-high, reversing	7000	50/100	700
Timken Roller Bearing Co.	Canton, O.	35	3-high	1500	355	2200
Universal Cyclops Steel Corp.	Bridgeville, Pa.	32	2-high	800	37/80	500
Weirton Steel Co.	Weirton, W. Va.	40	2-high, reversing	.....	.....	.....
Wheeling Steel Corp.	Benwood, W. Va.	35	2-high, reversing	.....	.....	.....
	Portsmouth, O.	35	2-high, reversing	.....	.....	.....
	Steubenville, O.	45 (s)	2-high, reversing	7000	50/100	750
				1650	112.5/270	750
Wickwire Brothers, Inc.	Cortland, N. Y.	18	2-high	.....	.....	.....
Wickwire Spencer	Tonawanda, N. Y.	32	2-high, 2 stands	2000	75	2200
Youngstown Sheet & Tube Co.	Campbell, O.	44	2-high, reversing	7000	50/130	700
	Youngstown, O.	40	2-high, reversing	.....	.....	.....
	Indiana Harbor, Ind.	46	2-high, reversing	8000	50/120	700

(s) — Universal mills.

90 per cent or more of the steel is charged at elevated temperatures.

Another important factor affecting fuel consumption is the use factor, or per cent of operation. This is well illustrated by the curves of Figure 18, which shows actual practice from a typical plant. Fuel consumption is almost doubled as production drops to about 25 per cent of plant capacity.

Fuel consumption also depends on the kind of fuel used, usually running higher in Btu consumption with the leaner fuels. Some reports show a Btu consumption with blast furnace gas 1.7 times as great as that obtained with coke oven gas.

Ingots are handled into and out of the pits by overhead pit cranes of 5-15 tons capacity. Two or three of these cranes are usually provided in each mill installation. The heated ingot is drawn from the pit by one of these cranes for transmission to the mill. In some cases, the ingot is carried directly to the mill table by the crane. The majority of installations, however, make use of an ingot buggy running on a track paralleling the line of soaking pits, and at some point of its travel making contact with the mill table. These electrically driven buggies travel at speeds of about 500 fpm and are usually operated by remote control, although in some cases, operators ride the buggy.

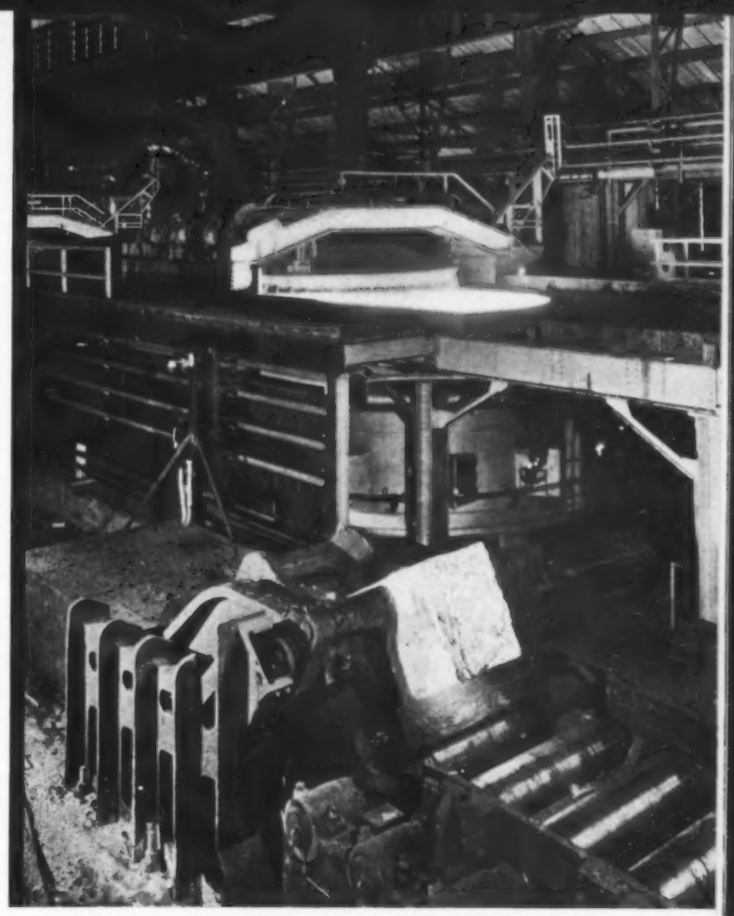


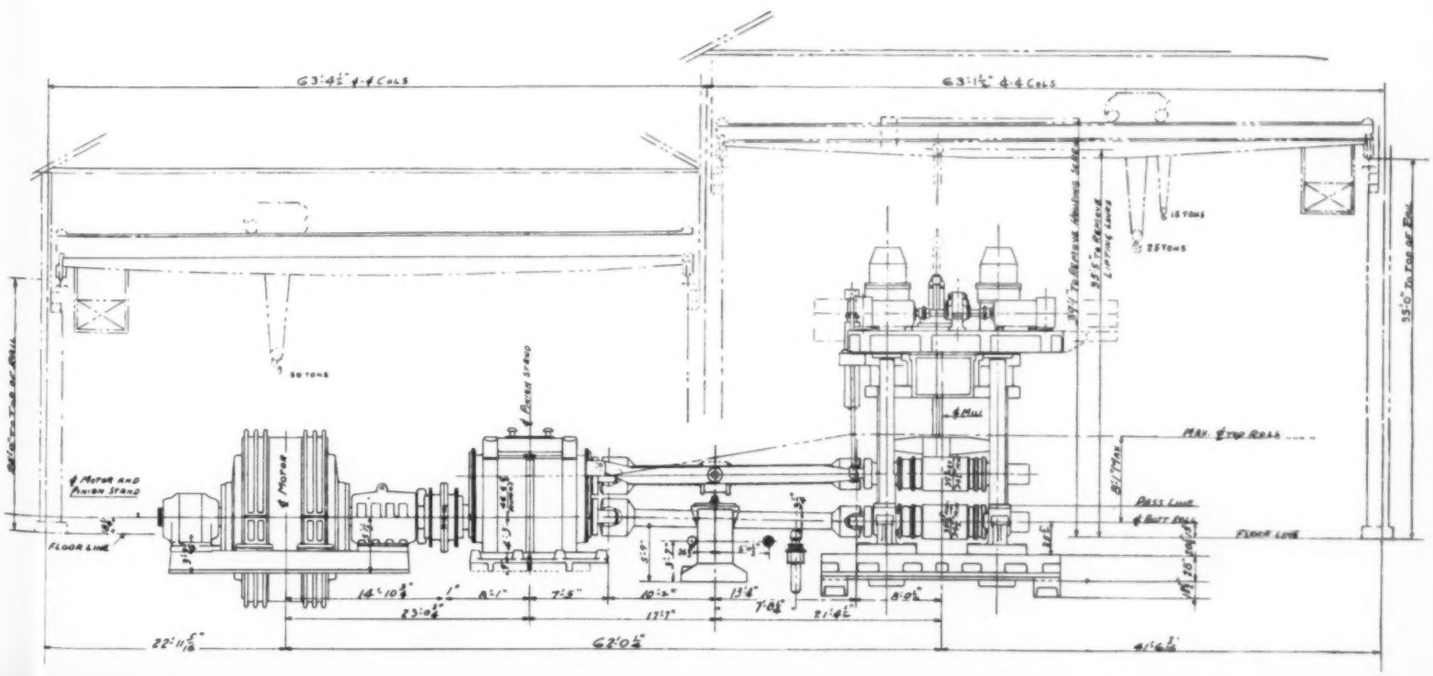
Figure 20 — Ingots are usually brought to the mill table in an ingot buggy as shown here. In the background is shown a modern pit of the circular design.

THE MILL

Table II is a listing of the blooming mills of the United States, giving size, type, and drive data. The usual method of stating the size of blooming mills is to use the distance, center to center, of the mill pinions. On this basis, we find the blooming mills of the country ranging up to 54 in. Most of the units fall between 34 and 46 in., with the newer mills at the top of the range. The gradual increase in mill size resulted from the gradually increasing size of ingots, brought on by the greater economies of pouring, stripping, handling and rolling the larger sizes. As the maximum ingot thickness depends on the mill size (in the ratio of about .55-.60 for good rolling conditions), the mill and its equipment must be selected with the ingot sizes in mind.

In comparison with many other types of mills, the blooming mill is relatively simple, usually consisting of a single stand of rolls. An inspection of Table II shows

Figure 21 — This section through the mill, pinions and drive exemplifies the modern blooming mill installation.



that the majority of the units are of the two-high reversing type. The single stand uses housings of cast steel of closed top type, of heavy, rigid construction to withstand the high stress and shock natural in the blooming mill. Large modern mills are designed for maximum separating forces as high as 3 or 4 million pounds, although such loadings are higher than usually encountered in blooming mills. Unit stresses allowed in the housings are usually of the order of 1200-1400 psi, requiring a sectional area of as much as 600-700 sq in. or more in each housing post in the heavier slabbing mills. In the regular blooming mills, the posts may be somewhat smaller, one 44 in. mill having a post area of about 500 sq in. and showing an average stress of under 1000 psi. Actually, the stress along the inner edge of the post is about double the average stress, while sharp corners, changes in section, shrinkage stresses, etc. may introduce magnification factors of as much as 10, giving localized stresses of the order of 10,000 psi. The post may have a section of H-type, with the bottom sections particularly heavy. The housings are rigidly tied together top and bottom by heavy separators. Housing shoes are accurately machined to fit the shoe plates, and each housing is held to the bed plate by heavy bolts. Housing windows are designed for simultaneous withdrawal of both top and bottom roll assemblies, preferably by a motor-operated rig. The housing usually accommodates two driven feed rollers on each side of the mill, each pair driven by motor of 35-50 hp.

Rolls — Blooming mill rolls are commonly of cast

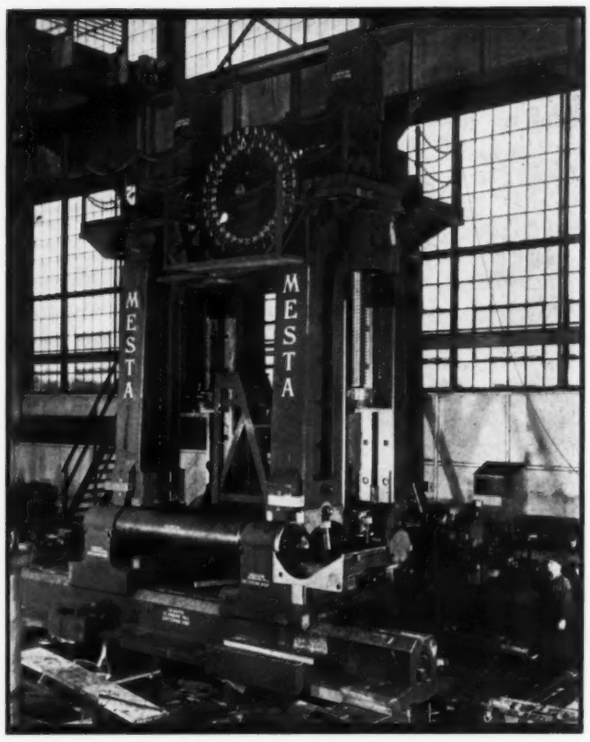


Figure 22 — This shop view shows the mill housing, with feed rollers mounted on each side of the mill.

TABLE III — Blooming Mill Data

	Tennessee Coal, Iron & Railroad Co.	Wisconsin Steel Works*		Steel Company of Canada*		Bethlehem Steel Company Sparrows Point			Republic Steel Corp., Massillon, O.
Number of pits	38†	24	....	20	....	....	88‡	....	28
Total pit hearth area, sq ft	3200†	1120	....	2188	....	....	5712‡	....	1490
Fuel	Coke gas	Mixed gas	....	Mixed gas	....	Mixed and blast furnace gas			Pr'cer gas
Btu per ton of ingots	....	985,000	....	875,000	....	....	....	....	....
Pit cranes, No. and size	(4) 15†	(2) 5	....	(3) 10	....	....	....	....	(3) 7½
Mill size, in.	46	40	32	44	34	40	46	40	34
Year installed	1939	1924	1938	1938	....	1916	1925	1929	1914
Roll diameter, in.	41	40	30	42	32	38¾	40	40	29
Roll body length, in.	104	92	72	96	72	92	92	80	84
Kind of bearings	Bronze & babbitt	Composition	Composition	Composition	Composition	Bronze & babbitt	Bronze & babbitt	Bronze & babbitt	Bronze & babbitt
Screw diameter	16	11½	12	15	14⅞	....	....	....	8
Screwdown motor, hp	(2) 150	(2) 140	(2) 100	(2) 150	....	....	....	....	(2) 25
Screwdown control	Variable voltage	Magnetic	Magnetic	Magnetic	Magnetic	....	....	....	Magnetic
Maximum roll lift, in.	....	....	....	51	24	....	....	....	30
Manipulator drive	....	Electric	Electric	Electric	Hydraulic	....	....	....	Electric
Main drive motor, hp	7000	7000	4000	7000	3000	7000	7000	7000	3500
Main drive motor, rpm	0-50-100	0-50-120	0-75-165	0-50-120	0-70-100	0-50-100	0-50-100	0-50-100	0-50-75
Main drive motor, voltage	700	700	700	700	600	600	650	650	700
Generator capacity, kw	(2) 3000	(2) 3000	(2) 2000	(2) 3000	(2) 2000	(2) 2000	(2) 3000	(3) 3000	1960
Motor-generator drive, hp	5000	4000	3000	5000	2000	3750	5000	6000	1500
Motor-generator drive, rpm	352	352	510	370	500	370	370	375	352
Vertical roll drive, hp	....	....	....	....	....	....	....	2500	....
Shear	Two, up & down cut			Tilt	....	....	....	....	800 ton
Maximum size cut, in.	36 x 10	180		10 x 10	....	....	....	....	8 x 8
Shear drive, hp	(2) 300	150		150	....	....	....	....	150

* Two mills in tandem.
† Serve two mills.
‡Serve three mills

steel, either plain carbon or alloy. In either case, the carbon content usually falls in the range of .50-1.25 per cent. Alloys may include manganese up to 1.00 per cent, chromium up to 1.10 per cent, nickel up to 2.50 per cent, and molybdenum up to .60 per cent. The lower carbons give resistance to breakage and to fire cracking, but at a sacrifice of hardness and wear resistance. To minimize fire cracking, chromium should be held to around .60 per cent or less, with carbon not much beyond .80 per cent.

Rolls are cast in a vertical position, usually in a dry sand mould. The metal is introduced into the mould at the bottom, with a swirling motion. The casting may be given a single or double anneal and may be normalized by cooling in air after the second anneal.

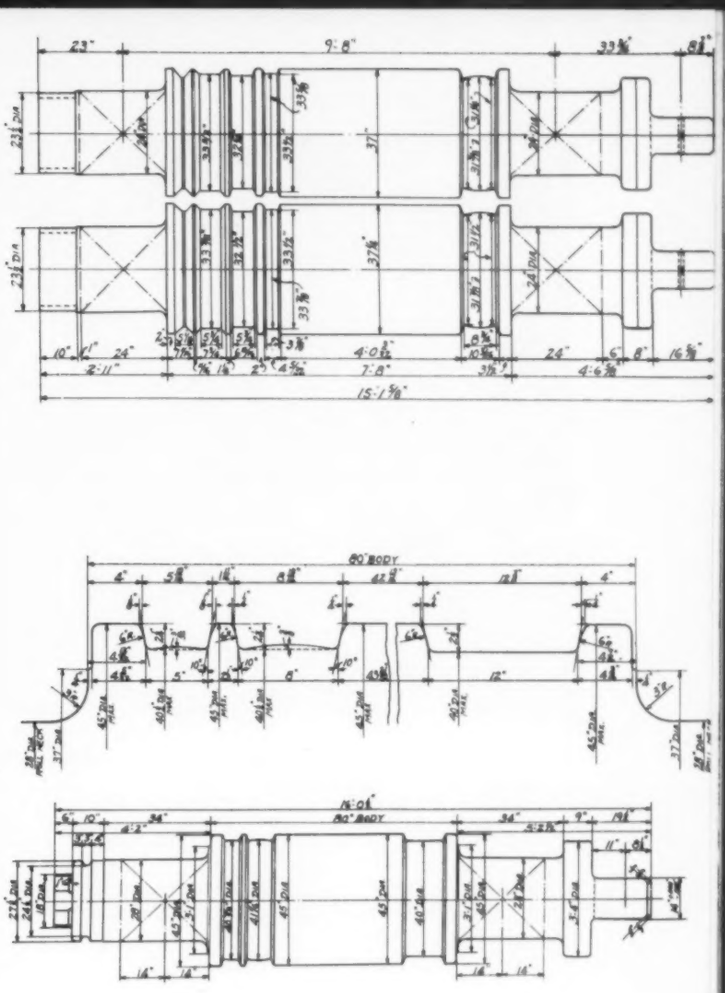
Roll diameter is usually 2-5 in. less than the mill size. The ideal roll diameter is about twice the size of the largest square ingot to be rolled, if deep ragging is to be avoided. The roll body length is set by the width of the mill in existing installations, averaging approximately twice the ideal roll diameter in the older mills and on up to 2½ in the later slabbing mills. In projecting a new mill, however, the mill width is determined from the roll length required to give the necessary roll profile to fit the desired rolling program. The number and size of grooves in the roll depend on ingot size and bloom size. The bullhead must be at least as wide as the original ingot width plus its spread. Bullhead widths range 24-36 in. for straight bloom rolling, and on up to 75 in. or more for slabbing work. The width of the grooves may be slightly greater than the width of the entering piece from the previous pass. A 20 in. x 20 in. ingot may be rolled to 8 in. x 8 in. in three grooves, and to 4 in. x 4 in. in five grooves. Typical grooves for bloom and billet rolling as used in one 40 in. mill are 3, 4, 5, 6, 8 and 12 in., plus bullhead in a roll body 92 in. long. A 32 in. mill uses 3, 4, 5, 6 and 8 in., plus bullhead in a roll 72 in. long. Another 40 in. mill has passes 4, 6, 8, 12 and 24 in. wide in a 72 in. roll. A roll 80 in. long contains grooves 4, 7¾, 11 and 42 in. wide. Another mill uses grooves of 4, 6, 8 and 12 in. and a 50 in. bullhead in a roll of 92 in. body length.

In slabbing mills of the universal type, a plain roll is usually adopted. In the blooming-slabbing mill, a wide bullhead pass with one groove pass on each side is common. Typical of this is a roll with a 73 in. bullhead, with a 13 in. pass on one end and a 6 in. pass on the other end.

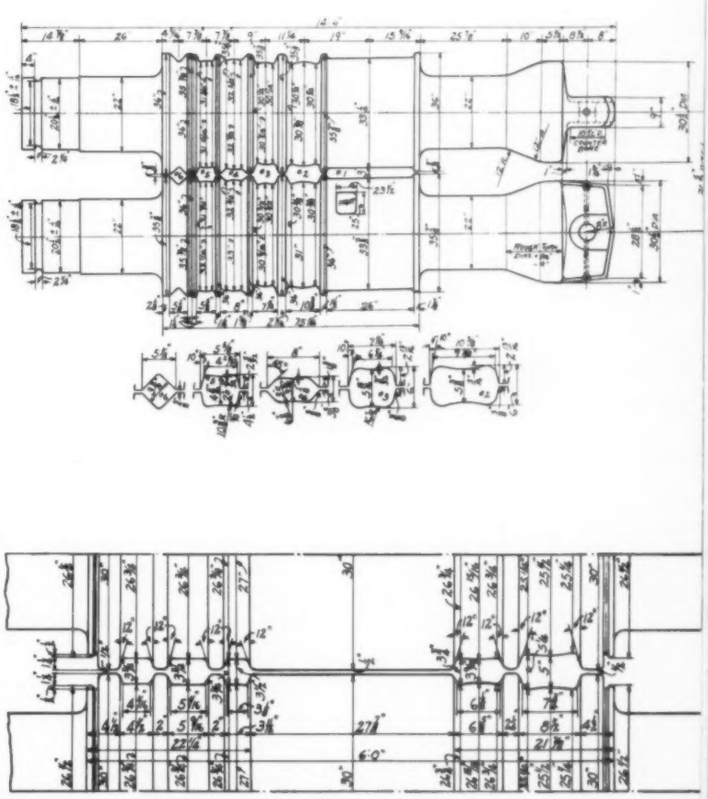
In some plants, the bottom of the passes are given a slight belly, which becomes more pronounced as the groove becomes smaller. This is done because, as the bloom becomes cooler, it tends to spread more at the center than at the top and bottom, giving convex sides. The belly in the pass tends to counteract this effect.

The depth of the collars separating the grooves seldom exceeds 3 in., which affords enough side protection for an 8 in. bloom. The width of the collar at its root is approximately equal to its depth. Taper of the groove may be as much as 15 or 17 degrees on the side.

In many mills the rolls are ragged in the larger passes, some quite heavily so as to insure a heavy bite on the ingot, some only 1/16 in. Other mills use no ragging



Figures 23, 24, 25 and 26 — These sketches show several designs of blooming mill rolls, the two above being particularly adapted to the rolling of wide slabs, while the two below are for general bloom rolling.



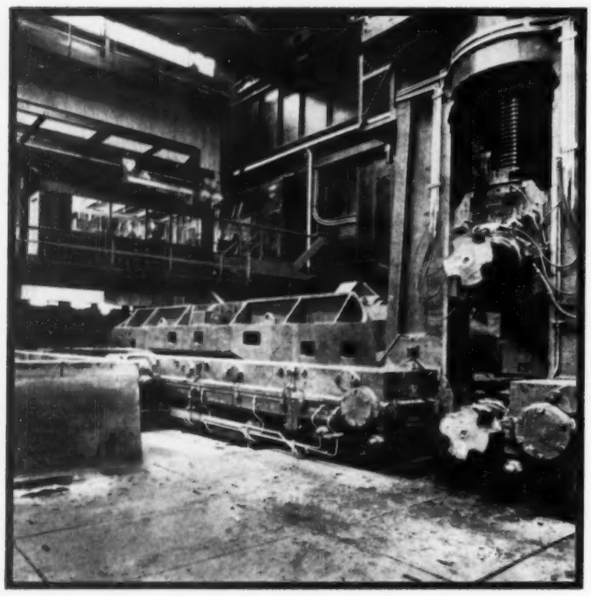
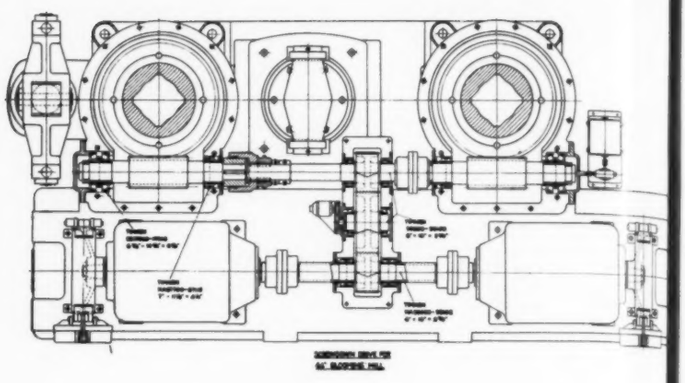
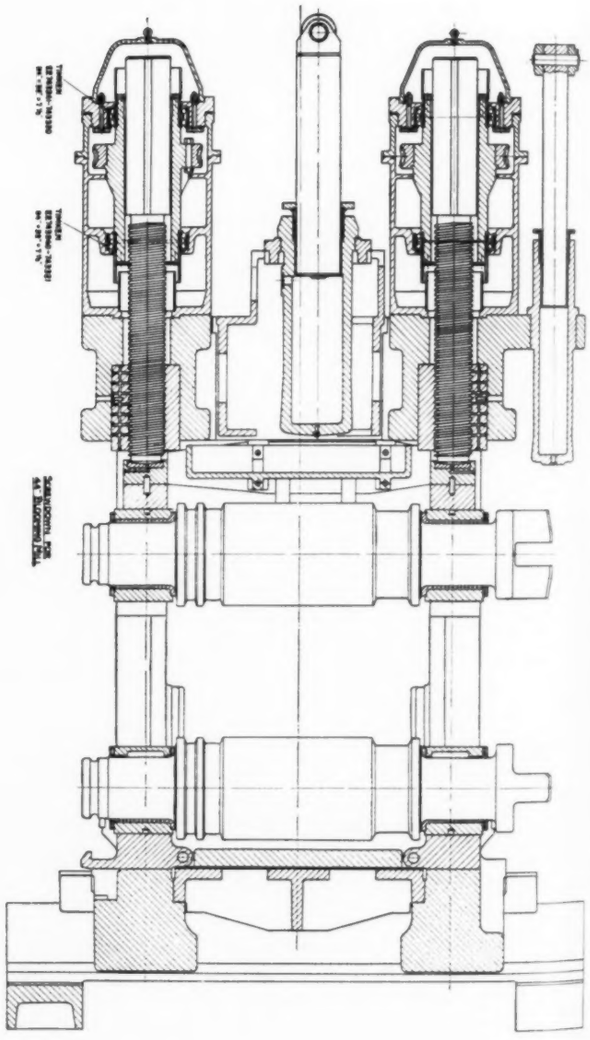


Figure 27 — This side view of the mill shows the arrangement of the chocks and bearings.



Figures 28 and 29 — Sketches showing the general arrangement of the mill screws and screwdown mechanism.



whatever, although the practice of roughing all passes slightly with a knurling wheel is widespread.

Roll life may total from as little as 100,000 tons or less for plain low carbon rolls up to 600,000 tons or more with alloy rolls. In modern practice, an average life of 250,000-300,000 tons is a reasonable figure. Where side wear makes frequent dressing necessary, this may drop to about 150,000 tons.

In dressing blooming mill rolls, a cut of approximately 3/16 in. may be taken, and rolls may be used until their original diameter has been reduced by 2.5-3.0 in. Thus, a roll is good for 7-9 dressings during its life.

Roll necks are usually proportioned to the roll body diameter in the ratio of .55-.70 to 1, running about 27 in. neck diameter in the modern mills using rolls of 43-45 in. diameter.

Roll changes are materially expedited by a motor-operated rig, which may consist of a cast steel carriage moving over a slab track and so designed as to engage and withdraw both rolls, with chocks, simultaneously.

Bearings — Roll neck bearings are, for the greater part, babbitted with brass grid inserts or bronze with babbitt inserts, proportioned for an average loading of 2500-2600 psi of projected area if subjected to the maximum stress for which the mill is designed. This means a projected area of about 750 sq in. in each bearing in the large mills. Working pressures are usually lower, however, running closer to 1200 psi if considered to be evenly distributed. This may not be the case, however, as the deflection of the roll may be such that pressures are localized. Likewise, if a bloom is rolled at one end of the roll, pressures are increased at that end and decreased at the other end, according to the respective moment arms. The life of such bearings ranges from 40,000 to 350,000 tons of production, the bottom bearings lasting longer than the rider bearings, and the pinion side of the mill giving shorter life than the work-

ing side. Automatic lubrication of roll neck bearings will lengthen their life considerably beyond that experienced with hand-packed lubricant.

Composition bearings, such as the laminated fabric phenolic types, are used on a number of mills with excellent results. Reports of bearing life with installations of this type show figures as high as 300,000 tons on top roll bearings and 800,000 tons on bottom roll bearings. For best performance with composition bearings, the roll neck must be smooth and polished, the bearing must fit the neck, and the water used for lubricant must be free from grit.

At the present time, the first installation of roller bearings for reversing slabbing mill roll necks in the United States is under way. This installation will be watched with interest.

The bottom bearings rest upon the sill of the housing window, while the top bearing assembly is held up against the end of the mill screw, being balanced either hydraulically or by counterweights. In the former method, a hydraulic cylinder may be mounted overhead in the top separator of the housing, while in the latter method, counterweights are located beneath the mill stand, with bars extending vertically through the bottom of the housing up to the top roll carrier. With bearings of bronze, babbitted or composition type, the top roll requires a carrier bearing and a rider bearing on each roll neck, working respectively below and above the roll neck.

Screwdown — The position of the top roll is adjusted by means of the mill screws, which extend down through the top of each housing. Mill screws range 10-18 in. in diameter, with single buttress thread of about 2 in. pitch. With buttress threads, there is no horizontal force component tending to split the screw box. Screws are driven through double worm or spur and worm reductions with ratios ranging from 4 to 30. The low ratios are found in the high speed screwdowns required by the high lift mills. Maximum roll lifts now range as high as 66 in., with lifting speeds as high as 28 fpm, as compared to the older figures of 25-30 in. and 3 fpm. The screws are of forged steel and modern practice seems to favor special alloy steel screws. Anti-friction bearings seem to be favored for the entire screwdown mechanism except the screws themselves.

Roll indicators are now usually driven by selsyn units.

The screwdown drive generally consists of two 230 volt d-c motors, of 100-200 hp and 500-400 rpm. If operating under variable voltage control, shunt motors are used, equipped with shunt brakes. If magnetic control is used, the motors are usually compound wound, with reversing-plugging-dynamic braking-series-parallel control. The parallel feature is used for long screwdown travel.

The screws operate in heavy screw boxes, usually of a bronze alloy 2-3 ft long, anchored in the top of each housing. Screw boxes of other materials, such as heat-treated alloy steel, nitrided steel, etc., are also showing excellent results. Regardless of the material used, it is essential that adequate provisions for good lubrication be made.

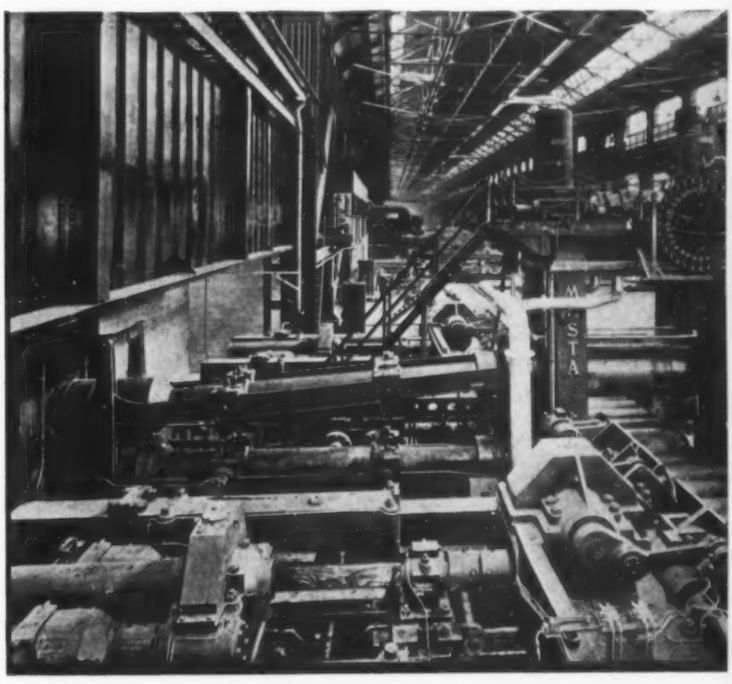
The average stress imposed on the threads should be kept low (say about 1200 psi) for both bearing pressure and shearing stress, as here again the forces are not uniformly distributed among the threads.

Pinions and spindles — The mill pinions, which serve to divide the drive power between the two rolls, are of cast or forged steel, with their pitch diameter establishing the mill size. They operate completely and tightly covered, in a pair of housings. Originally mill pinions were of spur type, which was later modified by dividing the pinion face into two parts, with the teeth in each part staggered. Now, however, pinions are of double helical design, of 16-20 teeth and 7-9 in. circular pitch, and generally of forged steel. In the newer, heavily powered mills, a pinion face of 65 in. is found. Pinion teeth carry working stresses of as much as 15,000-25,000 psi. Babbitted bearings are used in the majority of pinion stands. Lubrication of bearings and pinions is preferably accomplished by forced oil circulation. With proper lubrication, pinions will last for 10 years or more. Pinions absorb about 6 per cent of the power they transmit.

Mill spindles, which connect the pinions to the rolls, are of cast or forged steel, usually of universal type, with the bottom spindle running in spring-balanced carriers and the top spindle supported from carrier bars balanced hydraulically or by counterweight. Babbitted or composition bearings support the spindles. Since the spindles should not operate too far out of level, the modern high-lift mills require long spindles, running to as much as 27 ft, as compared to about 10 ft in the older mills. On the heavily powered units millspindle diameters range 16-23 in., being stressed to approximately 8000-10,000 psi. Motor-operated pull-backs on the mill spindles greatly facilitate roll changing.

The lead spindle, connecting motor to pinions, must be adequate to withstand the total torque for both

Figure 30 — This view of the drive side of the mill shows the arrangement of mill spindles, spindle carrier bars, etc.



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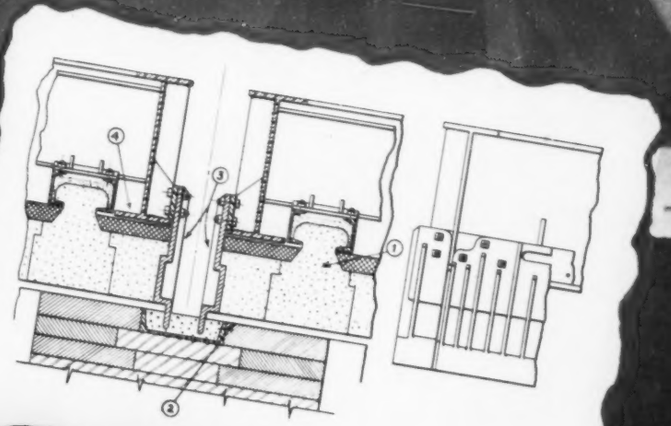

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TABLE VI — Data from Modern Blooming - Slabbing Mills

Company	Great Lakes Steel Corporation	Great Lakes Steel Corporation	American Rolling Mill Company	Carnegie-Illinois Steel Corporation	Inland Steel Company	Jones and Laughlin Steel Corporation	Youngstown Sheet & Tube Company
Plant	Ecorse	Ecorse	.....	Edgar Thomson	Indiana Harbor	Pittsburgh Works	Indiana Harbor
Location	Detroit, Mich.	Detroit, Mich.	Middletown, O.	Braddock, Pa.	East Chicago, Ind.	Pittsburgh, Pa.	East Chicago, Ind.
Year completed	1938	1930	1938	1937	1936	1936	1939
Size, in.	46	40	45	45	46	44	46
Type	2-high, reversing	2-high, reversing	2-high, reversing	2-high, reversing	2-high, reversing	2-high, reversing	2-high, reversing
Ingot sizes	23 x 66 x 90	24 x 47	19-20 in. thick Up to 63 in. wide 65-70 in. long 17,500-25,000 lb	21-33 in. thick 25-66 in. wide Up to 90 in. long Up to 55,000 lb	26x54x80—27,000 lb 24x43x76—20,000 lb	22x24— 7,700 lb 26x52—24,000 lb	23 round—6,900 lb 26x58—24,000 lb 32x42—21,600 lb
Product sizes	Slabs up to 64 in.	Blooms and narrow slabs	Slabs 4-6½ in. thick 24-76 in. wide 16-23 ft long	Slabs up to 60 x 8	Slabs 3-5 in. thick 10-42 in. wide 6-15 ft long	Blooms down to 7 x 8½. Slabs up to 50 in. wide, 3-5 in. thick.	Blooms down to 6 x 6. Slabs 4-6 in. thick, 15-52 in. wide.
Max. hourly rolling	.....	.....	.....	.....	313	250	200
Max. turn rolling	.....	.....	.....	.....	2213	1603	1600
Max. day rolling	.....	.....	.....	.....	4179 (16 hr)	4316	4200
Max. month rolling	.....	.....	.....	.....	108,034	112,868	115,000
Average hourly rolling	.....	.....	.....	.....	.....	165	150
Kwhr per ton, main drive	.....	.....	8.32	.....	10.4	12.44	12.76
Kwhr per ton, auxiliaries	.....	.....	4.07	.....	9.4	6.87	7.87
Roll diameter, in.	43	38	45	45	43	40	39
Length of roll body, in.	100	92	120	80	100	90	100
Kind of rolls	Alloy steel	Alloy steel	.....	.....	Alloy steel	Alloy steel	Alloy steel
Type of roll balance	Counterweight	Counterweight	Hydraulic	Counterweight	Counterweight	Hydraulic	Hydraulic
Max. roll lift, in.	66¼	46	36	66	57¼	46½	58
Roll lift speed, fpm	28.3	12.5	3.3	26	25.75	38.8	24-27
Screw diameter, in.	16	12	14	18	16	12	15
Screw pitch, in.	2	2	2	2¼	2	2	2
Screw motors, no. and hp	(2) 150	(1) 200	(2) 100	(2) 200	(2) 150	(2) 100	(2) 150
Screw motor control	Variable voltage	Magnetic	Magnetic	Variable voltage	Variable voltage	Variable voltage	Variable voltage
Max. separating force, lb	.....	.....	3,000,000	4,000,000	.....	1,900,000	.....
Housing post area, sq in.	.....	.....	600	700	.....	488	600
Kind of roll neck bearings	Babbitt, bronze inserts	Composition	Composition	Babbitt, bronze inserts	Babbitted	Babbitt, bronze inserts	Composition
How lubricated?	Grease system	Water	Water	Grease system	Grease system	Grease system	Water
Manipulator drive, no. and hp	(4) 150	(4) 150	.....	(4) 150	(4) 150	Hydraulic	(4) 100
Lift finger drive, no. and hp	(4) 50	(4) 50	None	.....	(4) 75	Hydraulic	(1) 150
Manipulator control	Variable voltage	Magnetic	Variable voltage	Variable voltage	Variable voltage	.....	Magnetic
Length of front mill table, ft-in.	42-7	42-11	.....	.....	42-11½	24-9	54-0
Front table drive, no. and hp	(2) 150	(2) 150	(2) 75	(2) 150	(2) 150	(2) 150	(2) 100
Front table drive control	Variable voltage	Magnetic	Variable voltage	Variable voltage	Variable voltage	Magnetic	Magnetic
Length of back mill table, ft-in.	42-7	42-11	.....	.....	42-11½	24-9	54-0
Back table drive, no. and hp	(2) 150	(2) 150	(2) 75	(2) 150	(2) 150	(2) 150	(2) 100
Back table drive control	Variable voltage	Magnetic	Variable voltage	Variable voltage	Variable voltage	Magnetic	Magnetic
Length of mill spindles	27 ft	.....	.....	.....	24 ft	21 ft 7 in.	23 ft 6 in.
Diameter of mill spindles	16 in.	18 in.	.....	.....	.....	19 in.	19 in.
Type of couplings	Universal	Universal	.....	.....	Universal	Universal	Flexible
Pinion type	Double cut helical	Double cut helical	None (twin drive)	None (twin drive)	Double cut helical	Double helical	Double helical
Pinion face width, in.	65	55½	.....	.....	65	54	50
Pinion pitch diameter, in.	46	40	.....	.....	46	44	46
No. of pinion teeth	20	20	.....	.....	20	19	23
Main drive motor, hp	7000	7000	(2) 5000	(2) 5000	7000	7000	8000
voltage	600	600	700	700	700	750	700
rpm	0-40-100	0-50-120	0-40-80	0-40-80	0-50-120	0-50-120	0-50-120
Operating torque, lb-ft	2,070,000	1,660,000	2,950,000	2,950,000	1,660,000	1,660,000	1,890,000
Max. torque, lb-ft	2,500,000	2,020,000	3,600,000	3,600,000	2,020,000	2,020,000	2,310,000
Generators, no. and kw	(3) 2500	(2) 3000	(3) 3000	(3) 3500	(2) 3000	(2) 3000	(2) 3000
M-g set drive, hp	6000	5000	7000	7500	5000	5000	5000
rpm	352	352	355	360	370	375	352
voltage	6600	6600	6600	6600	6600	6600	2200
type	Induction	Induction	Induction	Induction	Induction	Induction	Induction
Flywheel weight, lb	140,000	140,000	190,000	200,000	140,500	142,000	154,000
Flywheel diameter, ft-in.	15-0	14-7	15-0	15-0	15-0	15-10	15-0
Flywheel construction	Steel plate	Steel plate	Steel plate	Steel plate	Steel plate	Steel plate	Steel plate
Any descaling on mill?	No	No	Hydraulic jets	.....	No	No	No
Mill scale disposal	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits
Shear, type	Down-cut	.....	Double cut	Double cut	Down-cut	.....	.....
location	115 ft-5½ in. from mill	158 ft-5 in. from mill	In parallel table line	150 ft from mill	133 ft-5½ in. from mill	184 ft-3¼ in. from mill	170 ft from mill

Any descaling on mill?	No	No	Hydraulic jets	.....	No	No	No
Mill scale disposal	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits	Sluice to pits
Shear, type	Down-cut	.....	Double cut	Double cut	Down-cut	.....	.....
location	115 ft-5½ in. from mill	158 ft-5 in. from mill	In parallel table line	150 ft from mill	133 ft-5½ in. from mill	184 ft-3¼ in. from mill	170 ft from mill
max. size cut	64 x 6	46 x 6	76 x 6	60 x 9	40 x 8	400 sq in.	36 x 5 | 52 x 6
no. and hp of drive	(2) 275	(2) 230	(2) 275	(2) 250	(2) 263	Hydraulic	(1) 125 | (2) 275
control	Variable voltage	Magnetic	Variable voltage	Variable voltage	Variable voltage	Steam intensifier	Magnetic | Variable voltage
Crop disposal	Conveyor to pit	Conveyor	Chute to bucket	Conveyor	Conveyor	Chute to bucket	Chutes to buckets
Vertical roll location	None	None	33 ft from mill	In mill housing	None	None	None
Vertical roll, diameter	.....	.....	40	36	.....	.....	.....
length	.....	.....	24	80	.....	.....	.....
Kind of bearings	.....	.....	.....	Babbitt, bronze inserts	.....	.....	.....
Vertical roll drive, hp	.....	.....	2000	3000	.....	.....	.....
rpm	.....	.....	0-100-200	0-60-180	.....	.....	.....
voltage	.....	.....	700	700	.....	.....	.....
Max. opening between rolls	.....	.....	76 in.	82 in.	.....	.....	.....
Adjusting motor, no. and hp	.....	.....	(2) 75	(2) 75	.....	.....	.....

SOAKING PITS

Number	48 | 4	24 | 4	16	15	35 | 30	32 | 4	
Type	Reversing | One-way	Reversing | One-way	One-way recuperative	One-way, waste heat boilers	Reversing | One-way, recuperative	Reversing | One-way, recuperative	
Length	12-0 | 20-8	12-0 | 18-4	16-0	16-0 dia.	8-7 | 16-6	12 | 14-6	
Width	6-0 | 7-0	5-6 | 6-4	15-0	.....	5-6 | 7-2	7 | 6-6	
Depth	7-10 | 11-9	.... |	.....	8-4	8-3 | 11-6	8 | 14-0	
Total hearth area, sq ft	4035	2045	3850	3020	1650 | 3550	2688 | 377	
Kind of fuel	Producer or mixed gas	Natural gas	Coke and natural gas	Oil or coke gas	Coke gas | Coke gas or tar	Mixed coke gas and natural gas	
Controls	None | Full automatic	None | Full automatic	Full automatic	Temperature and furnace pressure	None |	None | Full automatic	
Temperature of charged ingots	Cold to 1200 F	25% cold	.....	25% cold 1600 F	12% cold 1500 F	1500 F	
Average heating time	7 | 6	.....	.....	8-10 hr, cold 3-4 hr, hot	12 hr, cold 4 hr, hot	1.5-2.0 x track, time	
Average Btu per ton	1,200,000 | 780,000	1,250,000	.....	1,325,000	750,000	982,000	
Pit cranes, no. and size	① 15, ② 7½	.....	③ 25	② 25/5	④ 15	① 10; ② 7½	
Ingot buggy	Yes	Yes	Yes	Yes	Yes	Yes	
	Note—These pits serve both mills listed above.				Note:—These pits serve two mills		

AMERICAN ARCH COMPANY, INC.

rolls. Recent mills with 7000 hp drives have lead spindles of 25 in. diameter.

Manipulator and sideguards — Tests have shown that the steel being rolled in the blooming mill is actually between the rolls only 25-40 per cent of the total rolling time. The remainder of the time is devoted to the manipulation of the ingot, entering it into rolls, etc. Thus, the mill auxiliaries become the important factor in setting the capacity of a mill. This is particularly true of the manipulator and sideguards. These units must be of rugged construction to withstand the heat, impact and heavy forces to which they are subjected, yet they must be light to be speedy. The operating mechanism must be placed so as to be accessible for maintenance, yet should be protected from mill scale.

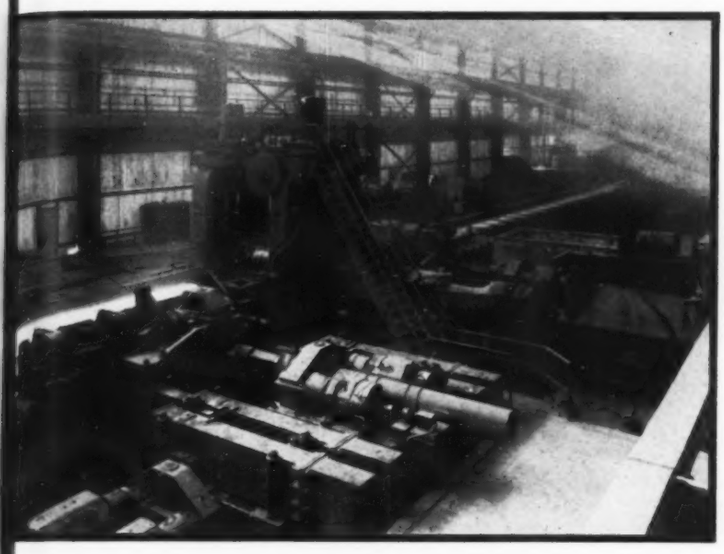


Figure 31 — Another view of the drive side of the mill, showing arrangement of side guard and manipulator finger drives.

▲

Figure 32 — Modern slab shears call for heavy, rugged construction, being designed to cut sections up to 600 sq in.

Manipulator drives are either hydraulic or electric, with the high acceleration and deceleration characteristics of the former keeping it in the running in spite of convenience and flexibility of the electric drive.

One of the recent hydraulic installations is of all-welded construction, with two movable side guard platens on each side of the mill carrying cast steel heads which form sides of the roller table when withdrawn to the outer limits. Each side guard on the front side of the mill is connected by a system of parallel links and connecting rods to pistons operating under a maximum pressure of 650 psi in hydraulic cylinders, with a maximum stroke of 7 ft 6 in. The side guards on the rear side of the mill are actuated by the same cylinders operating the front guards, through a 16 in. forged steel shaft. One of the front side guards carries five tilting manipulator fingers, hydraulically operated through links to give a 3 ft 6 in. lift. The hydraulic system is closed, with a pneumatic accumulator, and is provided with a centrifugal pump rated at 1000 gpm, 650 psi. A pressure system supplies grease lubrication to all essential points of the manipulator unit.

With the electric drive, the front and back side guards are usually driven through herringbone speed reducers, and are interconnected by rack pinion line shafts. In a new slabbing mill installation, the side guards consist of cast steel box sections 33 ft long x 4 ft 4½ in. wide, each with four renewable cast steel face plates 3 in. thick x 4 ft wide x 6 ft 4 in. long. Each side guard is connected to two rams spaced 16 ft 11 in. apart. The rams are forged steel slabs, 6 in. thick x 26 in. high, 35 ft 3 in. long for the drive side of the mill and 29 ft 5 in. long on the operating side. The maximum opening between the side guards is 115 in., and their stroke is 9 ft 7 in., with an overtravel of 3 ft 4 in. to permit changing the table rollers. Each of the four sideguards is driven by a 150 hp, 460 rpm shunt motor through a double reduction drive of 25.24:1 ratio. Forged steel rack pinions, of 34 in. pitch diameter, 5.357 in. circular pitch and 12 in. face, work in mesh with cast alloy steel racks attached to the underside of the rams. Four cast steel lift fingers are hinged into one entry side guard, and have a 4 ft lift. Lifting links are connected by a rocker shaft 12 in. in diameter, and are connected to a welded steel ram with a cast steel rack. Fingers are lifted and lowered through a double reduction gear drive of 15:1 ratio, by a 150 hp, 460 rpm compound wound motor operating under reversing-dynamic control. The lifting cycle is about 2 sec.

With magnetic control, the motors applied to the side guards are of reversing-plugging-dynamic braking type with jamming resistor arranged to operate the two drive motors permanently in series. If variable voltage control is used, shunt motors are used, connected permanently in series and provided with shunt brakes. Modern manipulator installations usually are driven by four 150 hp, 230 volt d-c motors, of perhaps 430 rpm. Manipulator fingers are often installed on both front and back sides of the mill, in order to eliminate the possibility of blind passes for edging. The fingers are driven through rack and planetary gear train by 75-150

hp motors. Modern designs are built to give a maximum sideguard speed of about 43 in. per sec. This speed is seldom reached, in view of the short travel, but results in the sideguard traveling across the mill table in perhaps 3½ sec.

Shear — The blooming mill shear is commonly located in line with the mill, at a distance of 100-200 ft from the mill. The shear is of up-cut or down-cut type, or a combination of both. Live roller tables are provided on both sides of the shear, and one or both of these may be depressed with each stroke of the shear.

The shear may be operated hydraulically or electrically. A typical hydraulic unit is one of 2000 tons size, with blades 52 in. long. The shear has an opening of 18 in., and a stroke of 20 in. It is operated under a pressure of 5000 psi, by a 32 in. diameter cylinder. This pressure is provided by a steam intensifier of 8 ft 8 in. stroke using a steam cylinder of 85½ in. diameter and a hydraulic cylinder of 14 in. diameter. Two pull-back cylinders of 19 in. diameter operate under a pressure of 500 psi. The hydraulic accumulator is 22 in. in diameter and has an 8 ft stroke. The air-operated shear gauge is actuated through two cylinders which lift or lower gates against which the piece to be sheared strikes.

Many of the older electrically operated shears were driven by a constant speed a-c motor with flywheel, with the shear actuated through a clutch. A number of the more recent installations, however, are of start-stop type, driven by two shunt motors of 200-300 hp, each with a shunt brake, and controlled through a variable voltage system.

One recent installation, of up-and-down cut type, is designed for a maximum knife pressure of 3,000,000 lb. The shear is capable of cutting carbon steel slabs up to 10 in. x 60 in., and blooms up to 14 in. x 18 in. An opening of 81 in. is provided between the housings, which are tied together by top and bottom separators. The shear has a stroke of 19 in., and operates by the top knife moving down until stopped at a point adjusted to suit the thickness of the stock being cut, while the bottom knife completes the cut. Both knife heads are oil-hydraulically balanced, and carry knives 9 in. x 4 in. x 80 in., with four cutting edges. The eccentric shaft, of forged steel, is 27 in. in diameter with a 9½ in. throw. The top knife shaft is 25 15/16 in. in diameter. The shear is driven through a two-speed reduction drive geared to give operating speeds of 9 and 16.6 cuts per min, by two 500 hp 375 rpm shunt motors under variable voltage and start-stop control.

Motor operated shear gauges may be of the screw type, using a bronze nut secured in the saddle casting which slides the entire length of the gauge on overhead side guides. These guides are supported at one end by the frame of the shear itself, and at the other end by a cross beam carried by stands mounted on special foundations. The gauge head, which is carried by the saddle casting, stops the bloom or slab at the selected point for which the gauge is set. Gauges may be designed

Figure 33 — These pushers and pilers handle slabs after they leave the mill and arrive in the storage or conditioning department.

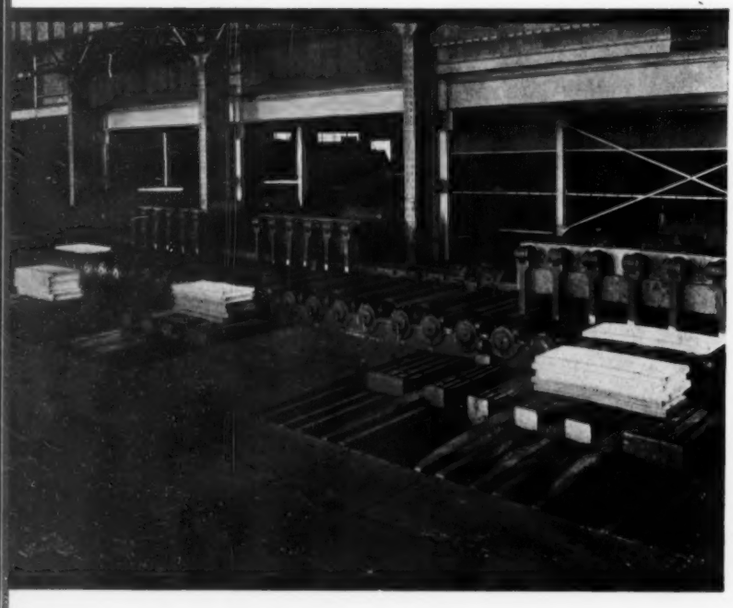


Figure 34 — Slabs or blooms may be moved from the mill line to storage over conveyors as shown here.

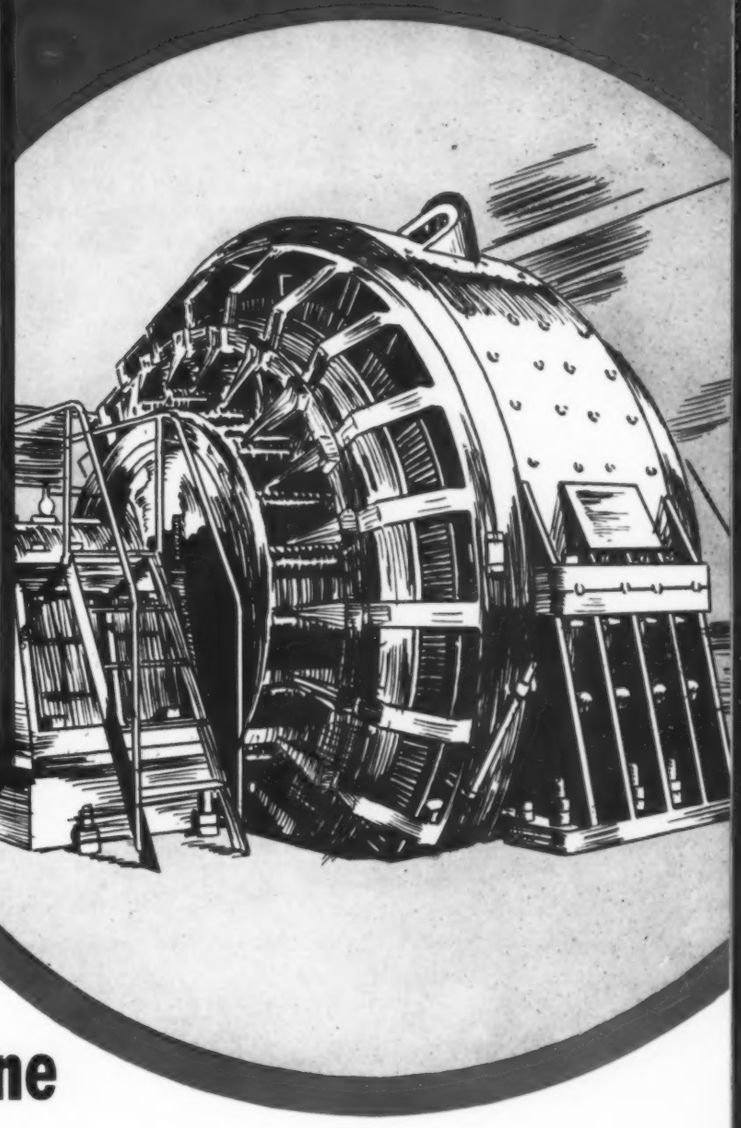
You Can Speed Up Reversing Mills

★

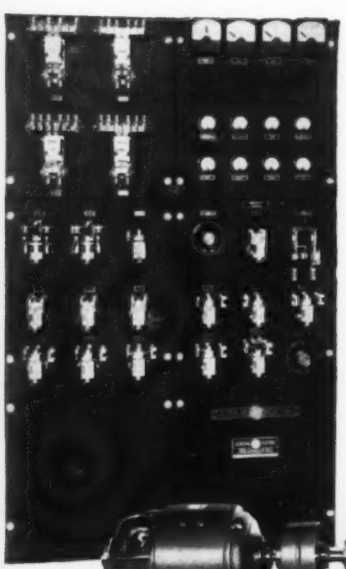
Cut Needed Control Devices by One Half

★

and Save Critical Materials



with the G-E Amplidyne



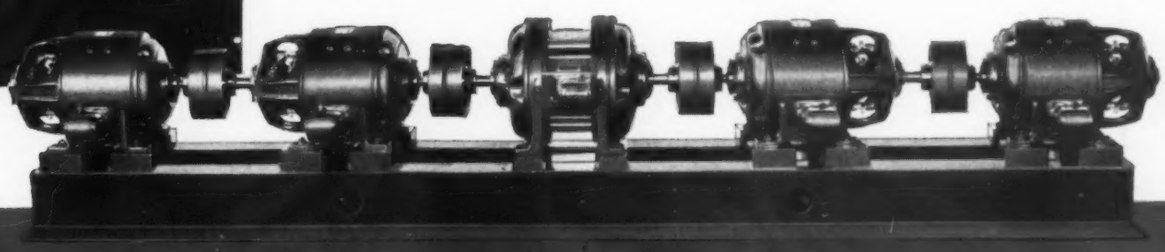
THE motor-amplidyne-generator set, which General Electric has applied to reversing-mill drives, permits the replacement of contactors—handling ***hundreds*** of amperes each—with relays handling a ***fraction*** of an ampere. This revolutionary change means not only longer life and less maintenance of the control devices—because relays are inherently easier to maintain than contactors handling heavy currents—it means also a ***50 per cent*** reduction in the number of control devices needed. Such a reduction saves maintenance time, ***skilled man-hours,*** as well as critical materials.

Speeds Up Output

The motor-amplidyne-generator provides accurate control of acceleration and deceleration of the mill, which is one assurance of maximum production. Effective load-limit control provides for maximum output of the motor. Improved voltage results from the use of the amplidyne—with resultant higher average speeds, and thus improved mill output. When twin drives are used, the amplidyne provides accurate load, torque, and speed balance between the drives.

If you would like more information about G-E amplidyne machines and their applications, see our local representative.

General Electric, Schenectady, N. Y.



G-E motor-amplidyne-generator set for control of reversing-mill drive. Relay panel at left.

GENERAL ELECTRIC

689-28-149

hp motors. Modern designs are built to give a maximum sideguard speed of about 43 in. per sec. This speed is seldom reached, in view of the short travel, but results in the sideguard traveling across the mill table in perhaps 3½ sec.

Shear — The blooming mill shear is commonly located in line with the mill, at a distance of 100-200 ft from the mill. The shear is of up-cut or down-cut type, or a combination of both. Live roller tables are provided on both sides of the shear, and one or both of these may be depressed with each stroke of the shear.

The shear may be operated hydraulically or electrically. A typical hydraulic unit is one of 2000 tons size, with blades 52 in. long. The shear has an opening of 18 in., and a stroke of 20 in. It is operated under a pressure of 5000 psi, by a 32 in. diameter cylinder. This pressure is provided by a steam intensifier of 8 ft 8 in. stroke using a steam cylinder of 85½ in. diameter and a hydraulic cylinder of 14 in. diameter. Two pull-back cylinders of 19 in. diameter operate under a pressure of 500 psi. The hydraulic accumulator is 22 in. in diameter and has an 8 ft stroke. The air-operated shear gauge is actuated through two cylinders which lift or lower gates against which the piece to be sheared strikes.

Many of the older electrically operated shears were driven by a constant speed a-c motor with flywheel, with the shear actuated through a clutch. A number of the more recent installations, however, are of start-stop type, driven by two shunt motors of 200-300 hp, each with a shunt brake, and controlled through a variable voltage system.

One recent installation, of up-and-down cut type, is designed for a maximum knife pressure of 3,000,000 lb. The shear is capable of cutting carbon steel slabs up to 10 in. x 60 in., and blooms up to 14 in. x 18 in. An opening of 81 in. is provided between the housings, which are tied together by top and bottom separators. The shear has a stroke of 19 in., and operates by the top knife moving down until stopped at a point adjusted to suit the thickness of the stock being cut, while the bottom knife completes the cut. Both knife heads are oil-hydraulically balanced, and carry knives 9 in. x 4 in. x 80 in., with four cutting edges. The eccentric shaft, of forged steel, is 27 in. in diameter with a 9½ in. throw. The top knife shaft is 25 15/16 in. in diameter. The shear is driven through a two-speed reduction drive geared to give operating speeds of 9 and 16.6 cuts per min, by two 500 hp 375 rpm shunt motors under variable voltage and start-stop control.

Motor operated shear gauges may be of the screw type, using a bronze nut secured in the saddle casting which slides the entire length of the gauge on overhead side guides. These guides are supported at one end by the frame of the shear itself, and at the other end by a cross beam carried by stands mounted on special foundations. The gauge head, which is carried by the saddle casting, stops the bloom or slab at the selected point for which the gauge is set. Gauges may be designed

Figure 33 — These pushers and pilers handle slabs after they leave the mill and arrive in the storage or conditioning department.

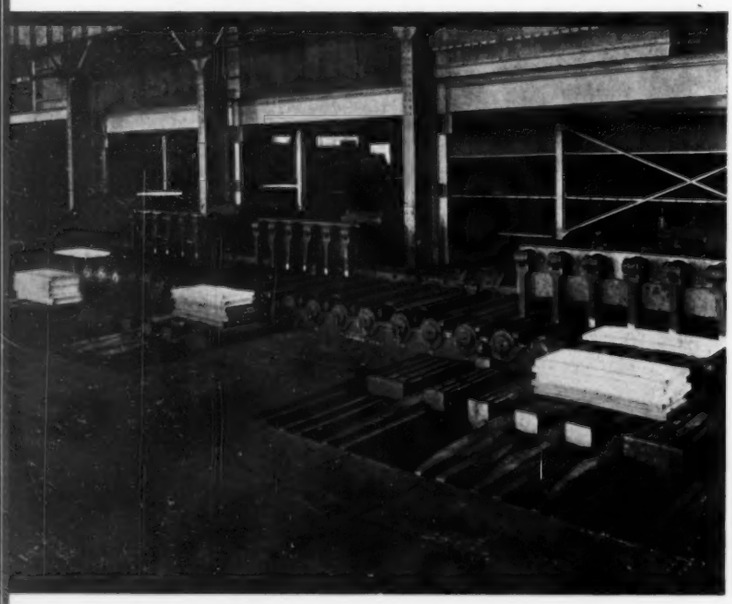


Figure 34 — Slabs or blooms may be moved from the mill line to storage over conveyors as shown here.

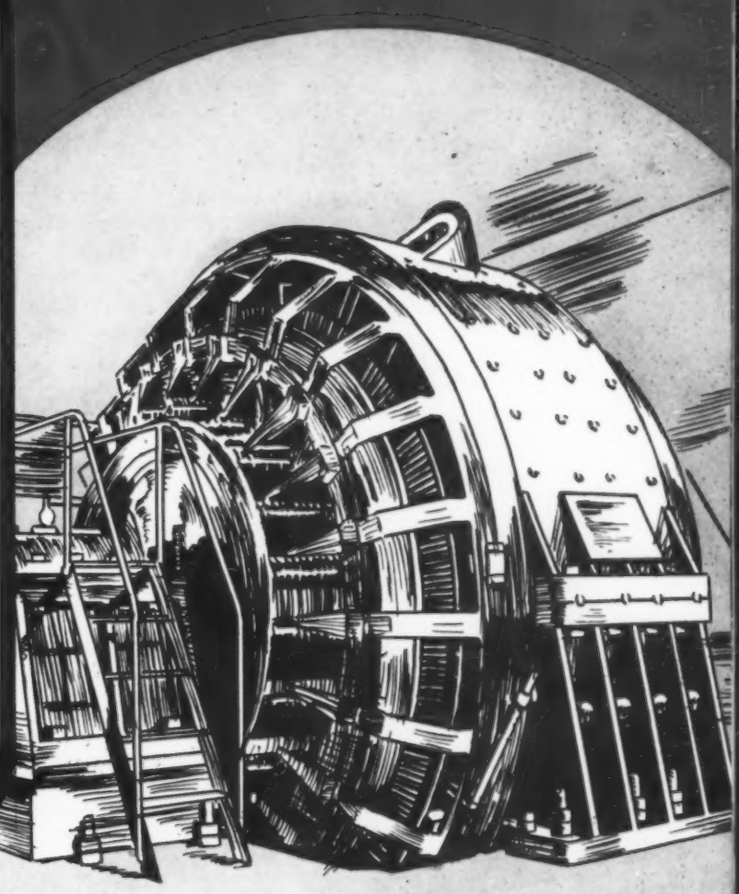
You Can Speed Up Reversing Mills

★

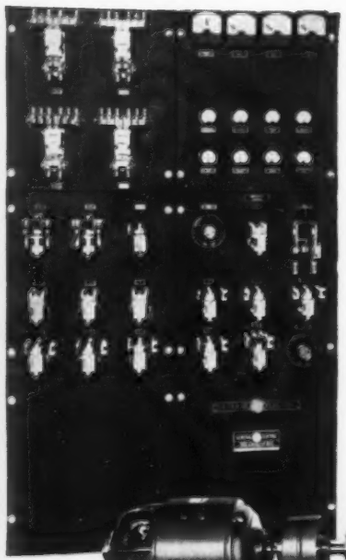
Cut Needed Control Devices by One Half

★

and Save Critical Materials



with the G-E Amplidyne



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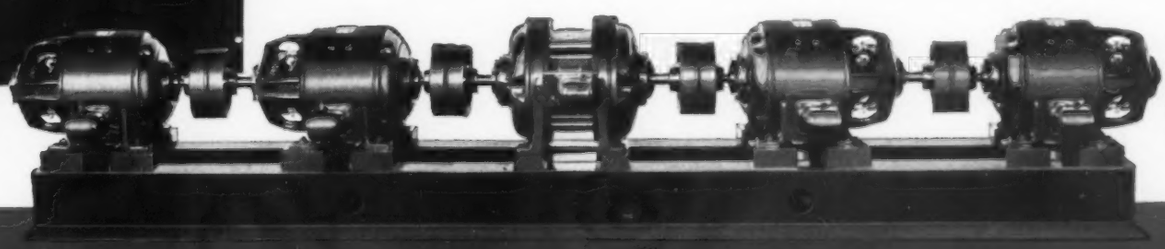


G-E motor-amplidyne-generator set for control of reversing-mill drive. Relay panel at left.

GENERAL ELECTRIC

689-28-149

to gauge bloom lengths over a range of 5-20 ft or more, usually in one inch increments.

The table at the delivery side of the shear is arranged to give sufficient space to allow the crop ends to fall through into a chute which may discharge into scrap buckets or scrap pits, or onto a flight conveyor which in turn discharges into a scrap car. One conveyor of this type has a rise of 1¾ in. per ft, and operates at a speed of 38 fpm.

Tables — From the time the ingot is brought from the pits to the mill until the finished bloom or slab is taken away, the material is carried by the mill tables. These units are therefore subjected to heavy loading, heat and shock, and must be of heavy design. Careful consideration should be given to problems of expansion and distortion resulting from the combination of stresses arising from heat and mechanical loading. Solid forged steel rollers are generally used, of generous size (12-20 in. in diameter, and of suitable width), and spaced on 2-3 ft. centers. Modern installations for heavy ingots show 16 in. diameter rollers, with 6-7 in. shafts, on rollers 6 ft. long, 18 in. diameter, with 8½-9 in. shafts on 7 ft. rollers, and 20 in. diameter, with 8½-9 in. shafts on rollers 9-9½ ft. long. The rollers are usually mounted in roller bearings, and carried by cast steel box section girders. The rollers are driven through bevel gears from a line shaft,which may run in a trough cast integral with the table girder. Table sections usually range 25-35 ft. in length. A single compound wound motor of 75-150 hp, with reversing-dynamic-plugging control drives the lineshaft through a double reduction drive of a ratio suitable to obtain the desired table speed, ranging 20:1 to 6:1. The width of the tables is generally the same as the width of the mill. In some cases (particularly with the wider mills) the full width is maintained only for a distance of 25-35 ft. on each side of the mill and narrower tables used for approach and run-out.

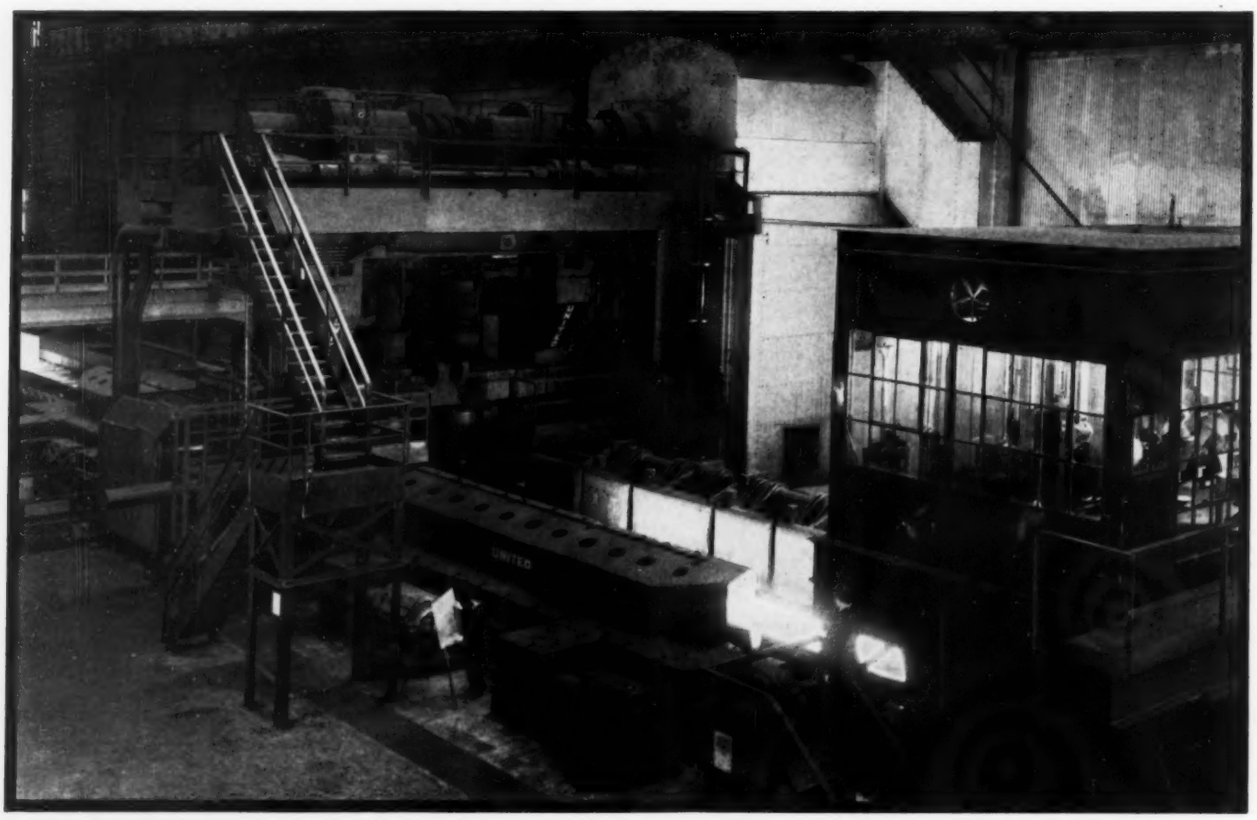
The front and back tables immediately adjacent to the mill are subjected to a much more severe duty cycle than the other tables, due to the reversing duty, and therefore require even more rugged construction and a larger drive. In the later installations, two 150 hp motors are often used on each of these tables, operated under variable voltage control. One modern installation uses 18 in. x 84 in. rollers on 29 in. centers for the tables with the exception of the front and back mill tables, where they are 20 in. x 115 in. The bevel gears are of forged steel, 5 in. face, with 22 teeth, 22 in. diameter on the lineshaft and 18 teeth, 18 in. diameter on the rollers. The lineshaft is 7½ in. in diameter, except for the front and back tables, where a diameter of 8⅝ in. is employed.

Approach and runout table speeds usually range 200-400 fpm, while the front and back tables are matched rather closely to the mill speed.

Underneath the mill tables, a trough is placed in the modern installations, through which mill scale is sluiced to settling pits, from which the scale may be periodically removed, preferably by overhead crane.

Slabs or blooms may be removed off the mill table by a pusher, perhaps of double ram construction with

Figure 35 — This modern universal slabbing mill is driven by a 10,000 hp twin-motor drive on the horizontal rolls and a 3000 hp motor on the vertical rolls.



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Heavy duty bus supports and group operated disconnect switches installed at Granite City Steel Company.

Below is a standard hook-operated 6000 Ampere disconnect for steel mill service.

No longer need a Steel Mill Engineer worry about heavy stresses where very high currents are used.

Here it's an R & I E Heavy Duty Bus Support to hold the 10 inch, double-channel conductor rigid under all operating conditions. And below note the straight line current path on the heavy-duty disconnect — built to carry full rated load continuously. They're Hi-Pressure Contacts (hinge and latch ends) but a 6,000 Ampere switch will open easily because pressure is relieved with the first pull of the latch.

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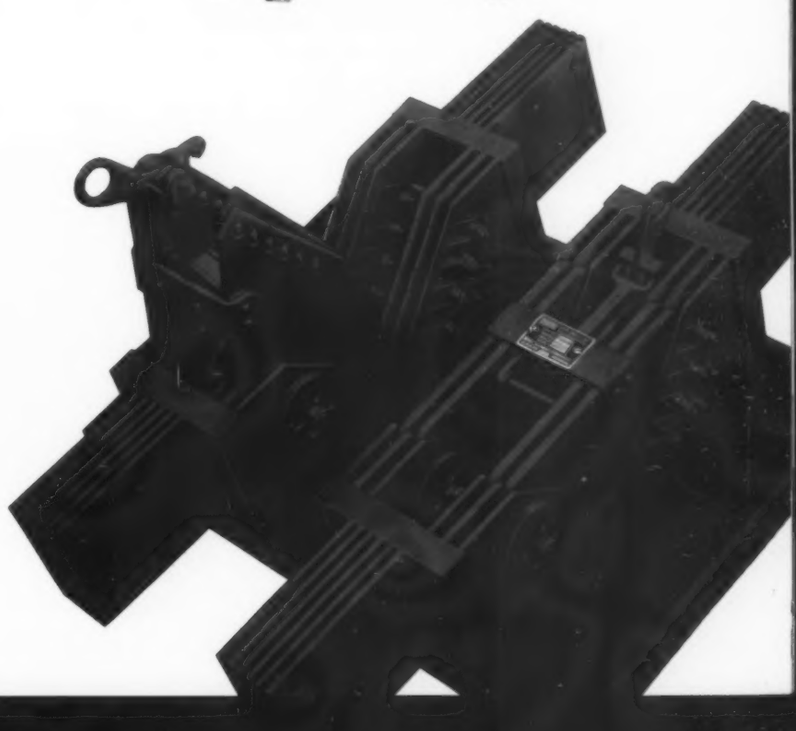

a number of hinged pusher fingers on 2 ft. centers, along a head 15-20 ft. long. The ram may be driven by a 35 hp motor at a top speed of 75-125 fpm, through a stroke sufficient to put the stock on to the transfer, cradle, or piler.

Many of the later transfers are of chain type, with skids on 2 ft. centers and steel link chains of 10 in. pitch running between the skids. The chains travel at a speed of about 100 fpm and carry pushing dogs spaced at such intervals as best fits the mill product. The width and length of the transfer are dictated by local arrangements, many ranging up to 20 ft. in width and 100 ft. or more in length. These transfers may also be of reciprocating type, with pull racks and ducking dogs, and a stroke of about 5 ft. Drive motors of 150-200 hp are usually found on the heavier transfers.

AUXILIARY DRIVES

It should be noted that, in the preceding discussions, auxiliary drives are operated either under magnetic control or variable voltage control. The latter system is a comparatively recent application of an old system, and affords flexible high speed operation and high acceleration and deceleration with smooth, stepless action. Resistor losses are practically eliminated, and a reduction in mill delays and maintenance can be expected. On the other hand, first cost of variable voltage control is usually higher than for magnetic control. The advantages are such, however, that variable voltage control has been used on almost all of the modern installations. In these applications, variable voltage control is usually used on the mill screwdown, sideguards, front and back mill tables, and shear. Power is supplied to the drives of these units from special motor-generator sets. One installation has two motor-generator sets, each driven by a 1000 hp, 6600 volt, 750 rpm synchronous motor and each having three 135 kw generators and one 250 kw generators, all of 250 volts d-c. The two 250 kw generators are connected to the two 263 hp shear motors; two 135 kw generators supply the two 150 hp screwdown motors, two 135 kw generators are connected to the four 150 hp motors on the sideguards, and two 135 kw units to the four 150 hp motors driving front and back mill tables. The feed rollers located in the mill housing on each side of the rolls are usually operated under the control used for the front and back mill tables. In this particular case, one motor-generator set also includes a 125 kw, 125 volt generator connected to a section of the mill table which contains a hot scarfing machine. Other installations are similar in character. Both motor-generator sets are required for full operation, although limited operations may be continued from one motor generator set if switching is so arranged. Generators for this type of service usually have self-excited shunt fields and heavy series differential fields in addition to the usually separately excited shunt fields, in order to obtain the desired characteristic. Figure 36 shows the basic connections for the generators and drives in this system.

The blooming mill installation may employ 30-50 auxiliary motors totaling 2000-3500 hp, in addition to the main drive units.

For the entire blooming mill, the average kw consumption is related to the connected hp of the mill in the ratio of .25 or .30.

MILL ARRANGEMENT

The usual arrangement of the blooming mill shows a single table line 50-100 ft. long leading up to the single mill stand, with another 100-200 ft. of tables leading from the roll stand to the shear. Beyond this, the layout varies according to local conditions. A pusher or kick-off may move the bloom or slab from the table into cradles from which an overhead crane carries them in chain slings. The pusher may move the blooms to a transfer which carries them into a storage building. In some cases, the blooming mill may be in line with a billet mill or a strip mill for direct re-rolling.

In some cases, the mill layout consists of two stands of rolls in tandem. An installation of this type is shown in Figure 40, where a 44 in. and a 34 in. are placed in line, 190 ft. apart, with a horizontal tilting crop shear between. A hot saw and transfer are placed on the exit side of the 34 in. mill, and blooms may be removed at this point or may proceed down the table to an 18 in. continuous billet mill. In usual practice ingots 22 x 24 in., 24 x 26 in., or 31½ x 31½ in. are broken down to 10 x 10 in. or 11 x 11 in. blooms in about 18 passes in the 44 in. mill. Slabs 30-42 in. wide and 4-12 in. thick are rolled from big-end up ingots ranging from 28 x 39 in. to 28 x 48 in. directly in the 44 in. mill which has a lift ample to edge a 51 in. width. Blooms may be

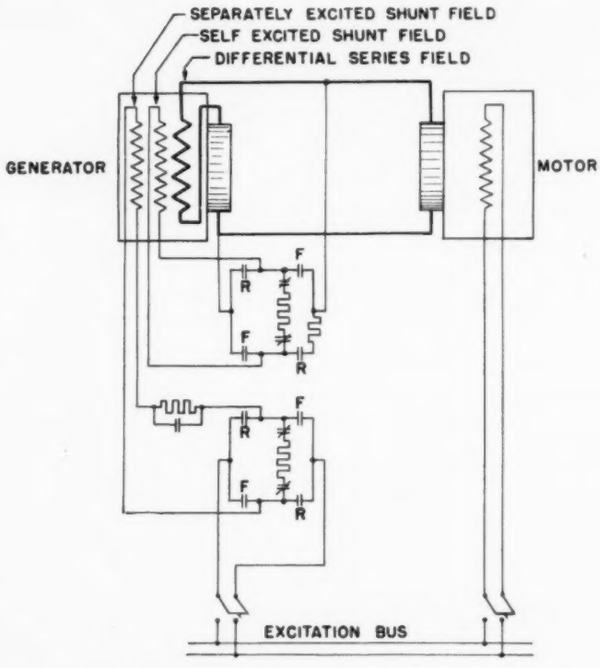

Figure 36 — Schematic wiring diagram showing basic connections for variable voltage control of auxiliary drives.

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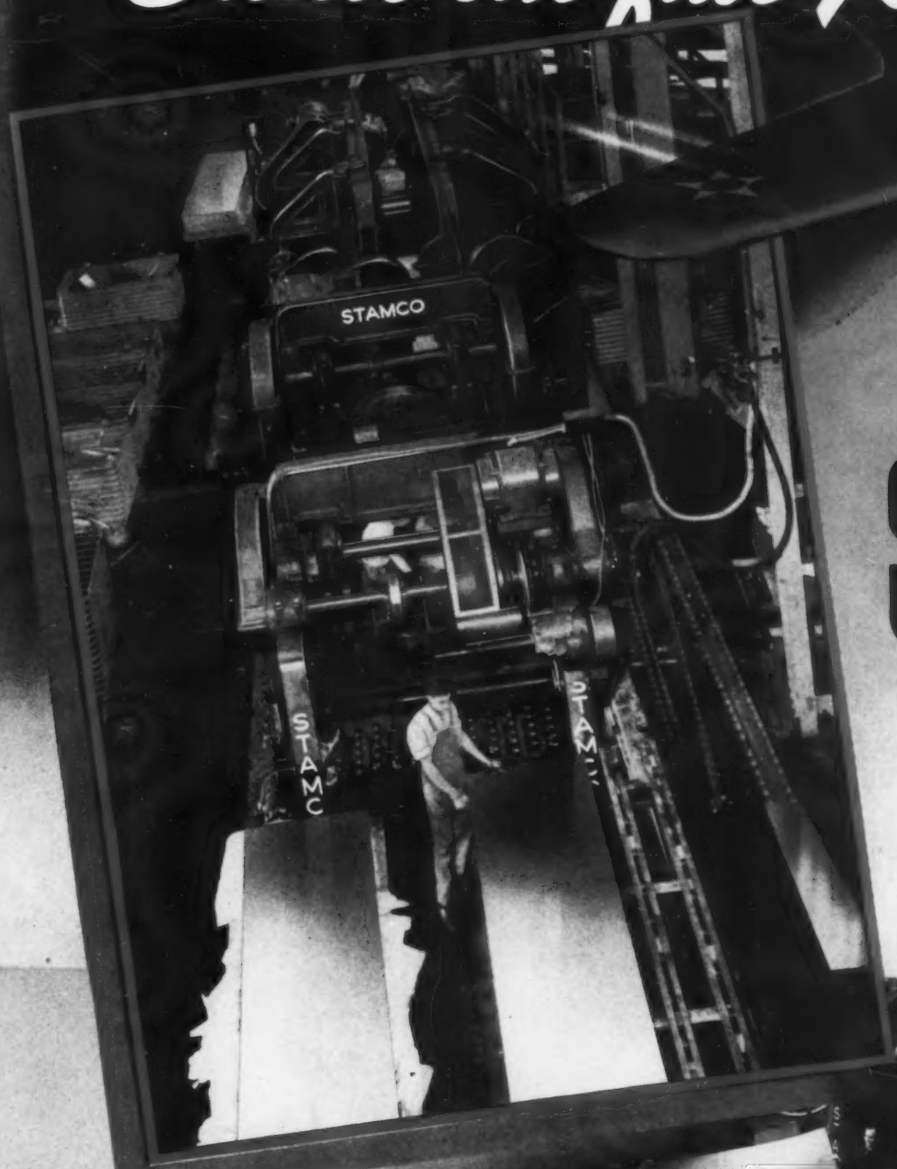

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NEW BREMEN, OHIO, U.S.A.

further reduced to 5¾ in. squares in 11 passes, or to slabs for sheet bar, in the 34 in. mill.

Another mill using two reversing units is illustrated in Figure 41. Here the units are placed in parallel mill lines about 27 ft. apart and connected by suitable transfers. The two mills are scheduled together somewhat as follows:

40 in. mill product, in.	*32 in. mill product, in.*
15 x 9½	8 x 8
13 x 7½	7 x 7
13 x 7½	6 x 6
11 x 7½	4 x 4
6 x 24	2 x 24
15 x 9½	15 x 4
9½ x 7½	8 x 3
10 x 7½	5 x 2½
7½ x 6¼	5 x 5
7½ x 6¼	4¾ x 4¾
7½ x 6¼	4⅛ x 4⅛
11½ x 7½	5¾ x 5¾
6 x 18	2 x 18

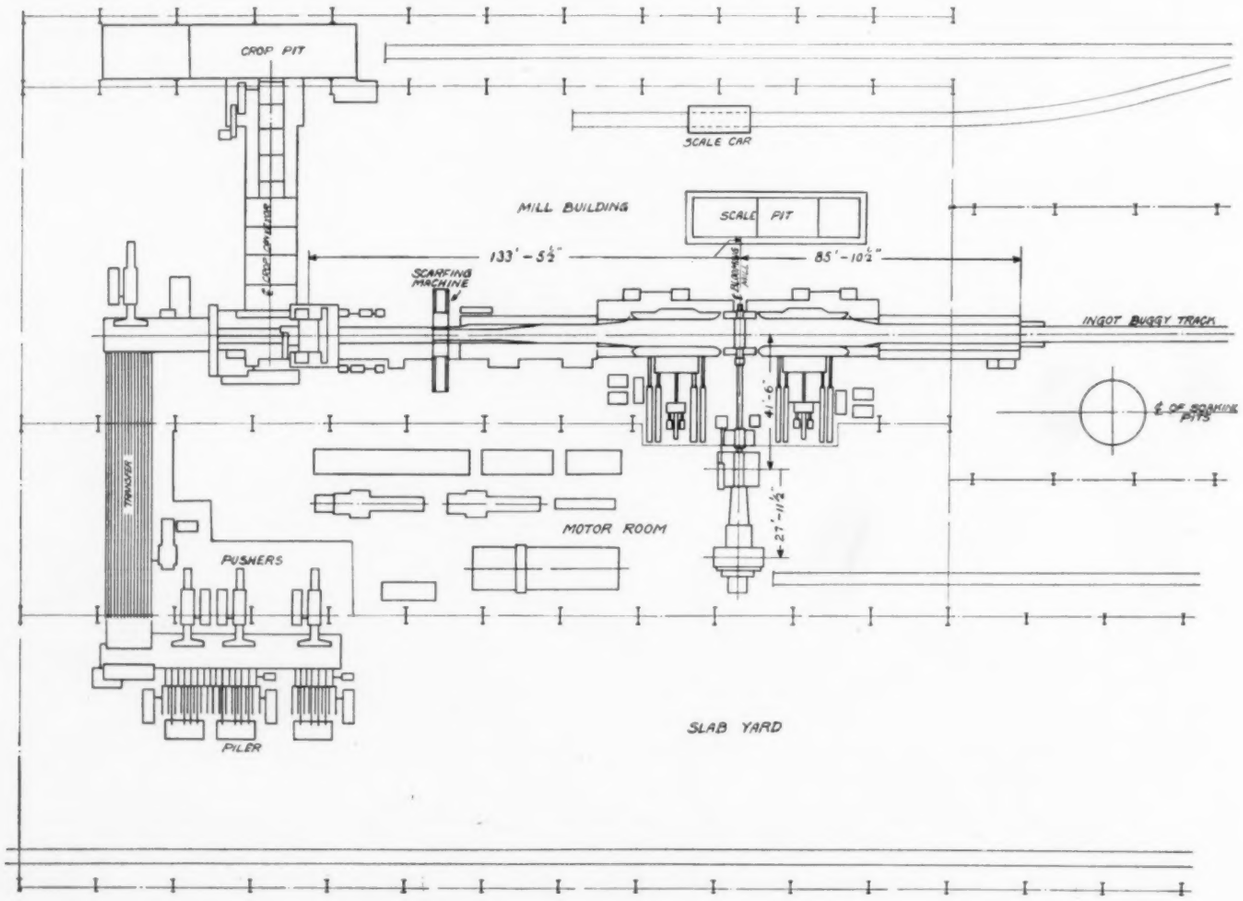
In both of the preceeding installations, either reversing mill can continue to operate while the other is down.

One unusual arrangement uses two 2-high nonreversing mills in tandem with a "merry-go-round" arrangement which returns the ingot to the first stand so that it receives two passes in each stand at a very slow rolling rate. The ingot then moves on to a 3-high blooming mill where the roughing operation is completed.

One of the most modern slabbing mills of the universal type, a 45 in. twin-motor unit, is shown in the layout of Figure 42. In this case, the slabs are moved from the mill line over a transfer to a parallel line where there are four more pushers and four pilers. This arrangement allows more time for slab cooling and is common in the later installations producing slabs. The horizontal rolls of this unit have a high lift so that the ingot may be edged for heavy edging passes in addition to the regular edging passes of the vertical rolls.

Another slabbing mill, of modified universal type, is shown in Figure 43. This design places the vertical rolls in a separate stand 30 ft. from the horizontal rolls, and is arranged so that broadside rolling may be done

Figure 37 — The Inland 46 in. slabbing mill is a high-lift unit located between the plant's two wide continuous strip mills.



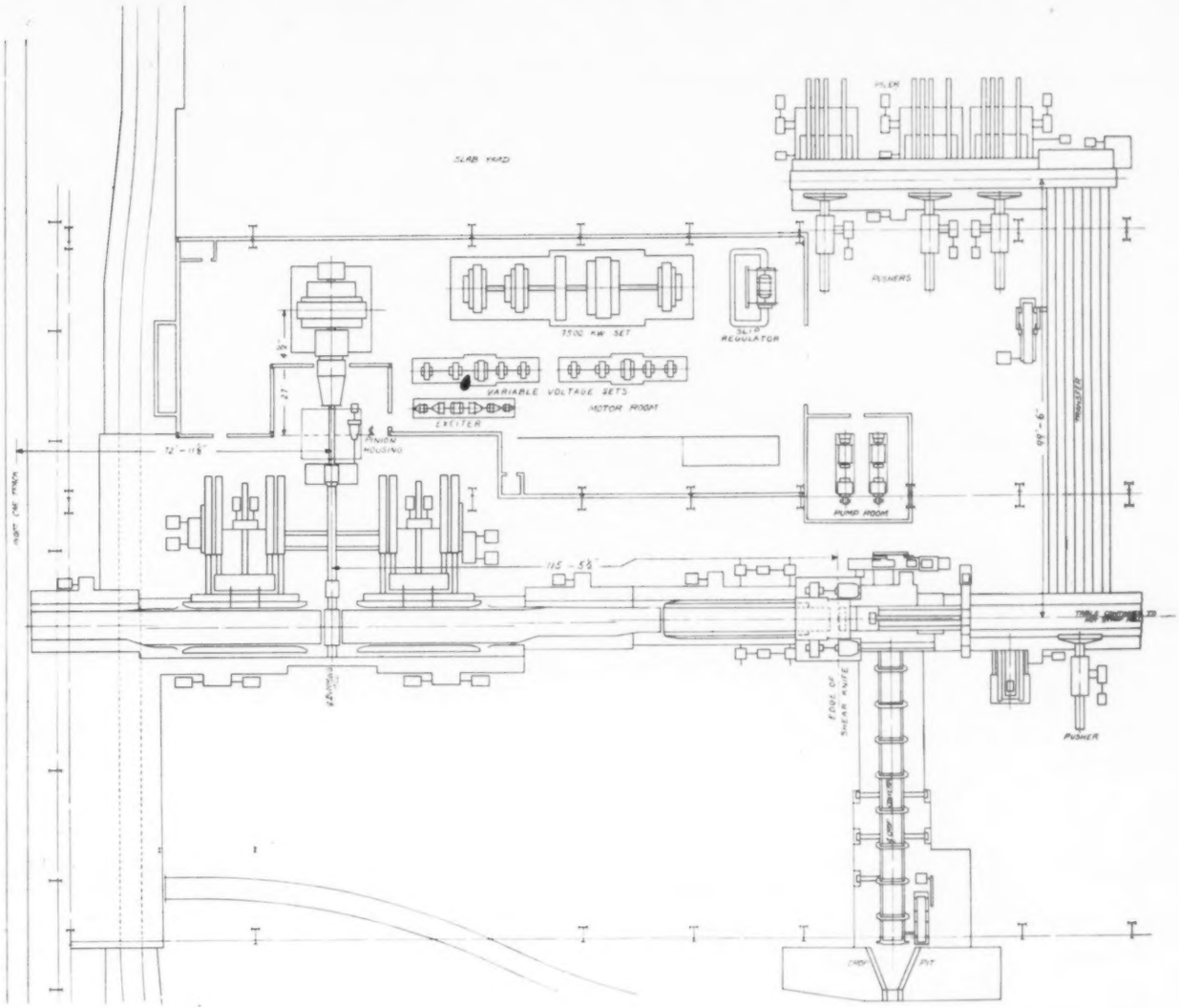


Figure 38 — (above) The Great Lakes 46 in. mill is also a high-lift unit, rolling principally slabs. Another bloomer is placed parallel to this unit, both fed from a row of pits running at right angles to the mill lines.

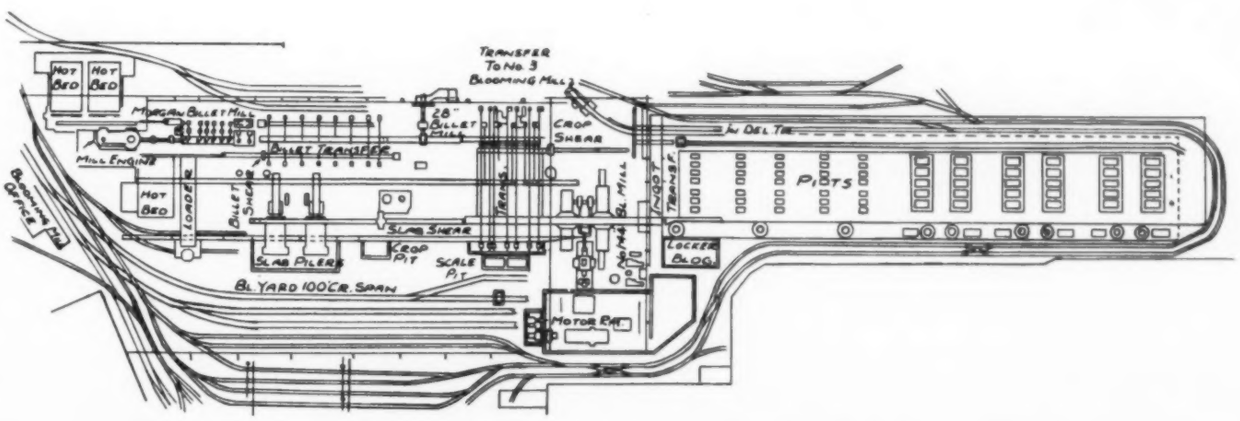


Figure 39 — (below) The 44 in. high-lift mill at Jones and Laughlin was built into the area formerly occupied by an old mill. The pits shown here serve two blooming mills.

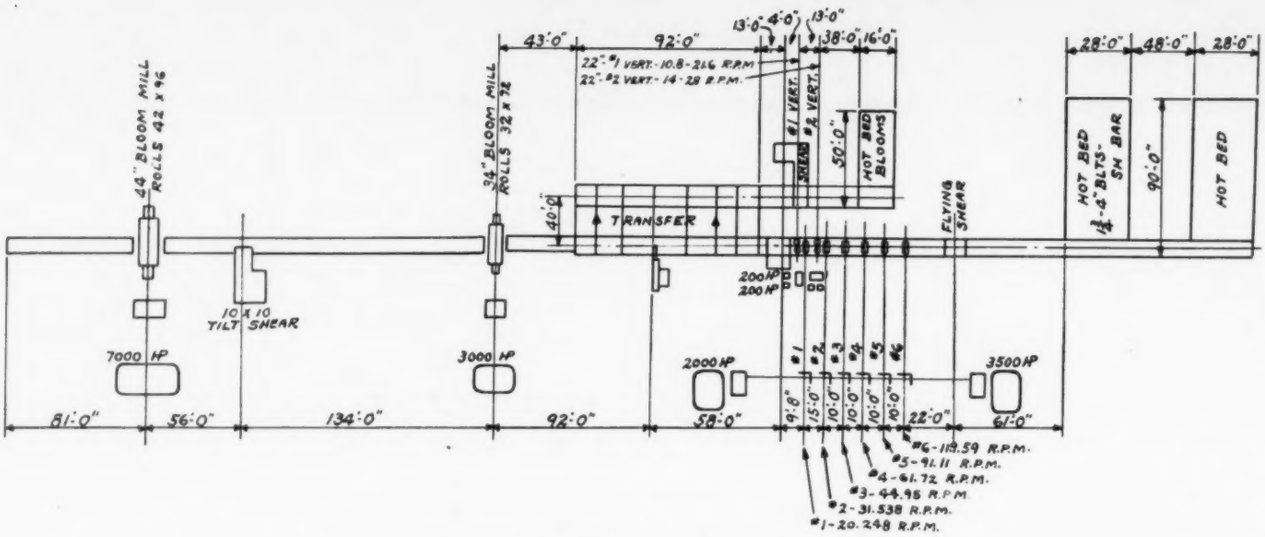


Figure 40 — At Steel Company of Canada, Ltd., two reversing units are located in tandem.

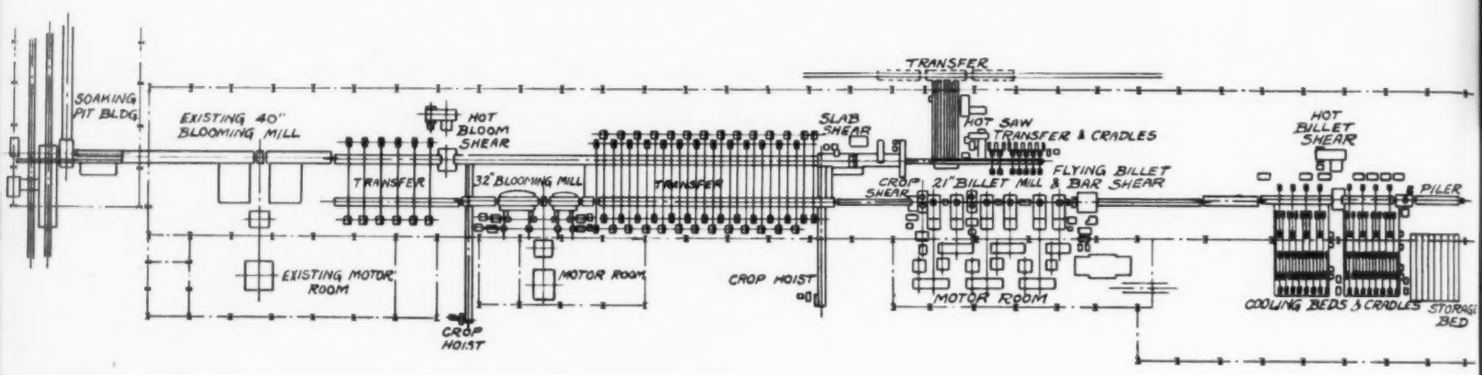
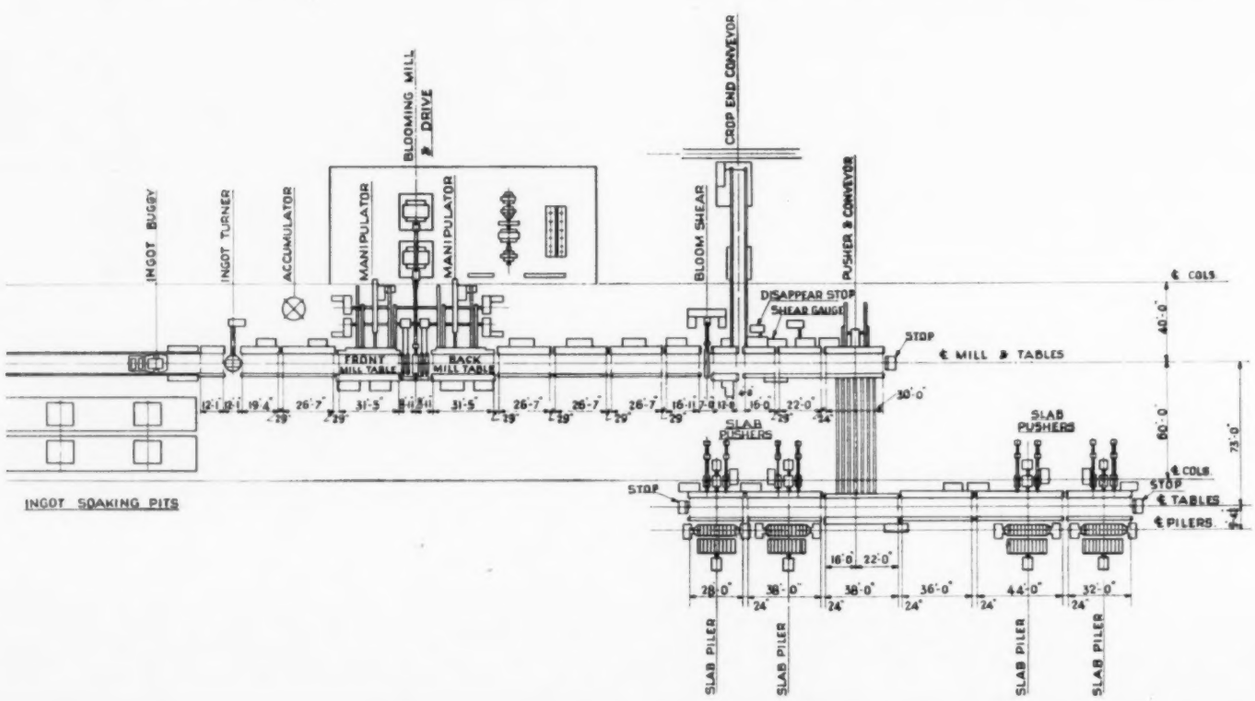


Figure 41 — (above) The Wisconsin Steel layout uses a 40 in. mill and a 32 in. mill located in parallel mill lines connected by transfers.

Figure 42 — (below) The 45 in. universal mill at Edgar Thomson plant of Carnegie-Illinois represents the modern, high capacity unit producing slabs only.



Schloemann Installations in a plate mill at Pittsburgh

Left—"Motor-Roller" equipped Scale Table

Below—
"Motor-Roller" equipped Shear Depressing Table

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With the rotating trunnion-type roller housing the driving motor, the necessity for using line shafts, couplings and gear reduction units is eliminated. Simplified table construction is the result, affording free access along both sides of "Motor-Roller" Tables.

Installation of rollers between the housings of Mill Stands and Shear Housings is possible without introducing complicated or weak elements.

Fewer wearing parts provide the ruggedness and dependability essential in mill service with reduced operating and maintenance costs.

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SC PITS GIVE THEM ALL!

CHECK THESE ADVANTAGES:

★ **Simpler Construction**—Burners and outlet flues located in one end wall. All other walls and the hearth are solid masonry backed by heavy steel binding. This is the simplest, sturdiest, longest-lived type of construction available for heating ingots.

★ **Increased Capacity**—In an existing space one-way fired pits can usually be laid out to provide considerably more capacity than other types.

★ **More Efficient Firing**—Fuel is admitted through properly designed burners, located in one end of the pit. There is continuous, uninterrupted travel of flame across the tops of ingots. Flame then doubles back in a horseshoe and the burned gases are exhausted through separate ports below the burners. Heating is by both radiation and convection.

★ **Better Heat Distribution**—Scientific burner design, regulating degree of premix and velocity of gas stream, affords complete control of atmospheric conditions and temperature distribution. Double travel of flame gives even temperature throughout the pit. Scale formation and oxidation losses greatly reduced.

★ **Fuel Economy**—Burners are scientifically designed. Air is preheated. Flame travels entire length of pit and then back. Combustion and furnace pressure control are automatic. Pits can be amply insulated against heat losses. The result —lower fuel costs.

★ **Greater Ingot Yield**—One-way pits can be fired up to maximum b.t.u. liberation in the combustion space available without injury to either equipment or steel. This permits maximum speed in heating steel—combined with increased capacity means much greater ingot yield.

★ **Lower Maintenance**—Inherent design features insure low maintenance: (1) Protected location of burner ports; (2) refractory arch is protected as direction of firing is parallel with arch; (3) recuperator is located so that amount of cinder or slag carry-over is negligible; (4) no reversing valves to wear out; (5) less materials used in construction.

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"Victory is written in ink on these charts! They tell a story in hot steel that will roll faster and faster until it spins into coils — 173 miles of rod every hour! . . . Or swings down the beds in bars and merchant shapes as fast as a tank can travel!

"My end's down here at the furnace watching these charts — keeping 'em in line. I get a great kick out of it because we're rolling steel on this mill, an' don't you forget it!"

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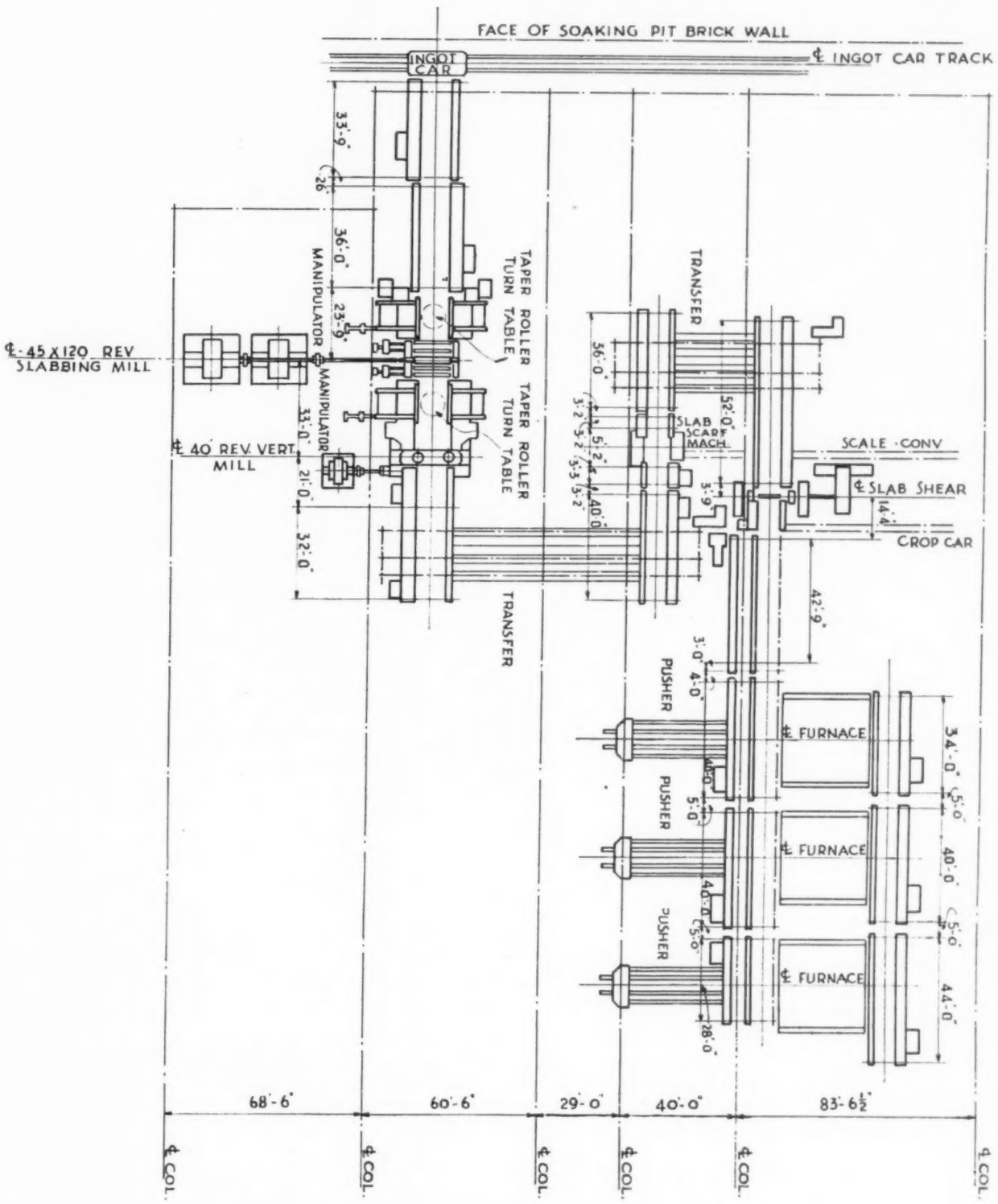

Figure 43 — The modified universal mill at Armco's Middletown plant has the vertical rolls separated from the horizontal rolls by 35 ft.

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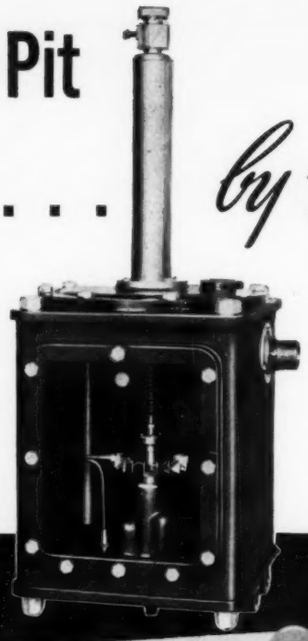
THE combustion control panels shown here are on five different makes of soaking pits or furnaces. Hagan Automatic Combustion Control was chosen because it is reliable, simple, sensitive, fast, stable — the requirements for trouble-free operation.



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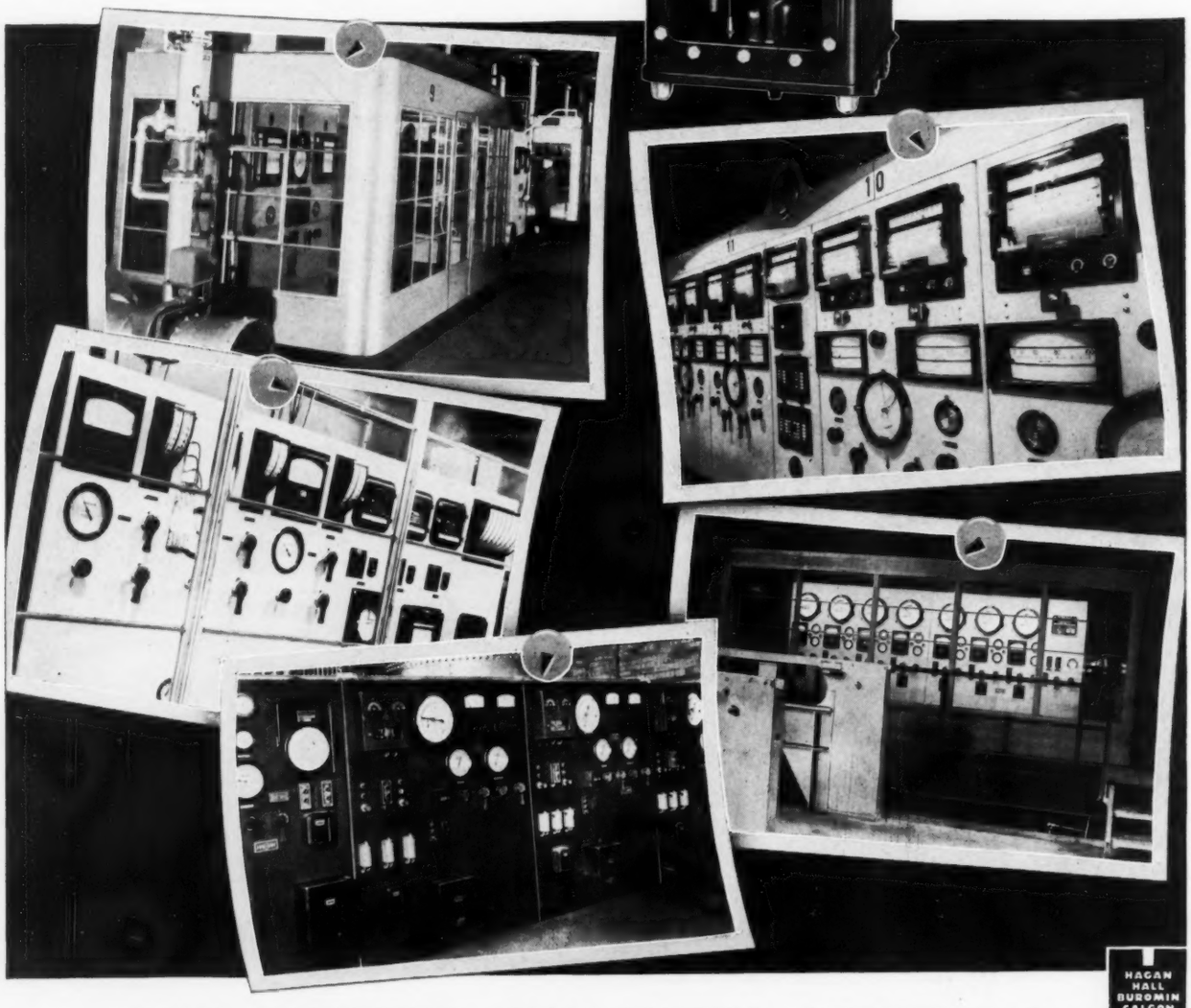

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in the horizontal rolls. The ingot is turned by the action of the table rollers, which are alternately tapered in the opposite direction, and alternately driven by separate drives. Operation of the drives in opposing directions thus turns the ingot through 90 degrees. From the runout table of this mill, a transfer leads to a parallel table containing a hot scarfing unit, and another transfer leads to charging table serving the slab heating furnaces of a continuous strip mill. Thus, hot slabs are delivered directly from the slabbing mill to the strip mill. The broadside rolling in the slabber eliminates all broadsiding in the strip mill.

OTHER MILL TYPES

Thus far, our discussion has centered around the two-high reversing mill, which is the type in common use. There are, however, some installations using other types of mills, the most common of which is the three-high mill. In the three-high mill, the position of the three rolls is fixed and the reduction schedule is fixed for a given set of rolls, with 7, 9 or 11 passes usually provided. The roll body diameters are slightly different, the top roll being the smallest and the bottom roll the largest. Each roll is driven through a spindle from a pinion, and the middle pinion is connected to the drive, which is non-reversing. A lift table is provided on each side of the mill, of a length at least equal to the longest length leaving the mill. These tables, which are counter-weighted and operated electrically or hydraulically are raised and lowered in unison, carrying the blooms between the top and bottom pass lines.

The fixed pass schedule naturally limits the sizes entering and leaving the mill with a given set of rolls. The three-high mill therefore lacks the flexibility of the two-high mill. It cannot effectively carry out high elongation schedules, and does not have the rigidity to successfully roll large ingots. On the other hand, the three-high mill is lower in cost than a two-high reversing unit, and has a higher rate of production for a given schedule. Power consumption of the three-high mill is also lower than that of the two-high mill, approximately 70 per cent of the drive power being actually used in deforming the steel.

There are about 14 three-high blooming mill installations in the United States, ranging from 20 in. to 46 in. in size. These are driven by steam engines or induction motors with flywheels. The drive is smaller than that required for equal schedules with reversing duty, because of the flywheel effect and the absence of acceleration and deceleration requirements.

There are several continuous blooming mill installations in the United States. One of these consists of four two-high 42 in. stands on 25 ft. centers, and four two-high 32 in. stands, spaced on 10 ft, 25 ft, and 10 ft centers. The first four stands are each designed to take a 25 per cent reduction and produce 6½ in. squares. The piece is turned between the first and second passes and between the third and fourth passes. Smaller sizes (3⅞ in. squares, 5½ in. squares or 8 in. x 2 in. slabs) are produced by the second group of stands, where twist guides are provided between the first and second passes and between the third and fourth passes. The piece is turned on the table between the second and third passes. The entire tandem train is driven through line shaft, spiral bevel gears and herringbone pinions by an 8000 hp, 240 rpm, 13,200 volt induction motor with phase wound rotor. Originally built to roll 1500 lb ingots, this mill has been complemented by the installation of a 44 in. two-high reversingunit to reduce large ingots to a suitable size.

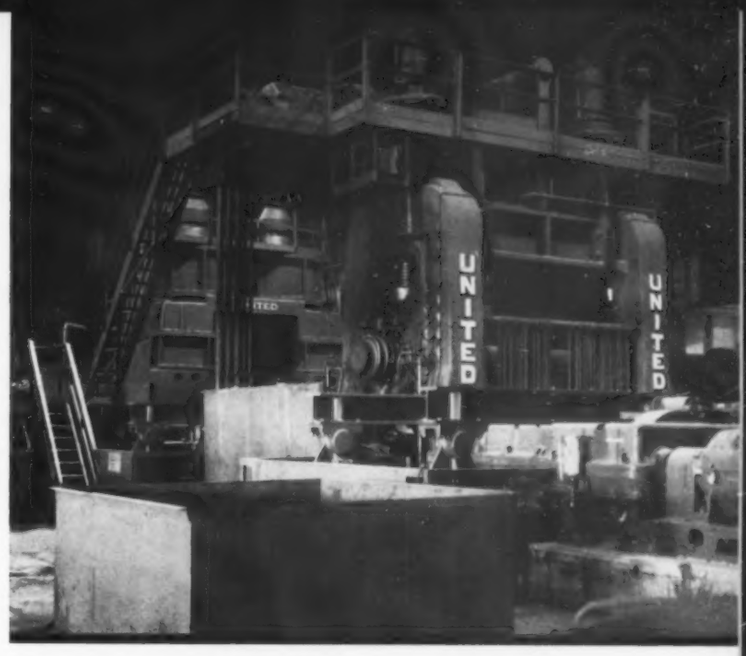

Figure 44 — View of modified universal mill showing the two separate stands holding the horizontal and vertical rolls.

Another installation, part of a continuous billet mill, consists of four 40 in. two-high stands driven by two 2000 hp motors and five 32 in. two-high stands driven by a 6000 hp motor. Billet mill trains of 24 and 18 in. follow these breakdown stands. Still another unit, consisting of four 40 in. two-high stands driven by two 2000 hp motors and one 40 in. three-high stand driven by a 6000 hp motor, breaks down ingots for a rail mill. Mills of this type are naturally extremely limited in flexibility, but, on a given size, can produce extraordinarily high output.

REDUCTION OF THE INGOT

Steel in the ingot stage has a dendritic structure, and is subject to a number of defects, including piping, blow holes, segregation, crystallization, slag inclusions, scabs, checks, etc. These defects will not be considered in this discussion except as they influence or are influenced by the blooming mill process. The mechanical working given the ingot in the mill improves the quality of the metal by refining its crystalline structure, forcing its particles into closer contact and closing up cavities. Strength, hardness and ductility of the steel are all affected. In view of these points, the first passes in the mill should be made at slow speed and with light drafts (5 per cent reduction of area or less), being used principally for squaring up the ingot and tightening up its structure. Subsequent drafts can be as heavy as the mill will bite and roll, although limited by excessive side pressure and spreading. If a square, sharp-cornered bloom is desired, the reduction in the final passes must be reduced.

Blooming mills are usually designed to take a "bite"

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of as much as 2-3 in. on the steel, reducing the sectional area by as much as 40-60 sq in. Reductions of area may run 5-8 per cent for the first several passes, and 10-20 per cent for the remainder, perhaps dropping back to 5 per cent for the last pass. Figures 45 and 46 show reductions used in two blooming mill schedules. The first of these is perhaps more typical of general practice, while the latter is a little more unusual, the roll being designed for more definite entering and exit sizes. It should be remembered, however, that in all two-high mills the reduction schedule is largely in the hands of the roller, who varies his drafts according to the character and behavior of the steel in the mill. Proper handling in the mill has a profound influence on the quality of the steel, and considerable damage may be caused by mishandling.

In the three-high mill, the ingot size and the bloom size for a given set of rolls is fixed. Likewise, the number of passes is fixed, with eleven passes a practical maximum. Hence the mill is limited to moderate reductions (usually 5 or 6 elongations), but within its limits, the three-high mill has a much greater capacity than the two-high reversing mill. As one pass is rolled over the preceding pass, the groove in the middle roll must serve for both the bottom and the top passes. Drafts are heavy, being made usually as great as the bite of the rolls will permit, but running somewhat greater in the bottom passes than in the top passes. Drafts of 3-3½ in. in the bottom passes and 2½ in. in the top passes are typical. Collars have little slope, and little or no room is allowed for spreading. Reduction of area is seldom under 10-12 per cent in any pass and range up to perhaps 25 per cent.

In slab rolling, drafts of 1-3 in. are normally taken, with due consideration of the available torque. The wide sections of the slab ingot result in higher separating forces in the mill, and consequently require high driving torque. Hence, drafts must at times be limited according to the drive power. With sufficient power it is possible to reduce 27 in. slab ingots down to 6 in. slabs in nine flat passes, with edging passes following the third and sixth flat passes. Usual practice, however, shows 17-23 passes. Oscillogram records subsequently given in this discussion show typical slab rolling procedure (Figures 48, 50 and 52).

As the steel is passed between the rolls, a certain amount of lateral spreading occurs. The amount of spreading depends on a number of factors, and is very difficult to determine. General observations include the following:

Open hearth steel (low phosphorus) spreads more than bessemer steel (high phosphorus).

Slow rolling speeds give greater spread than high rolling speeds.

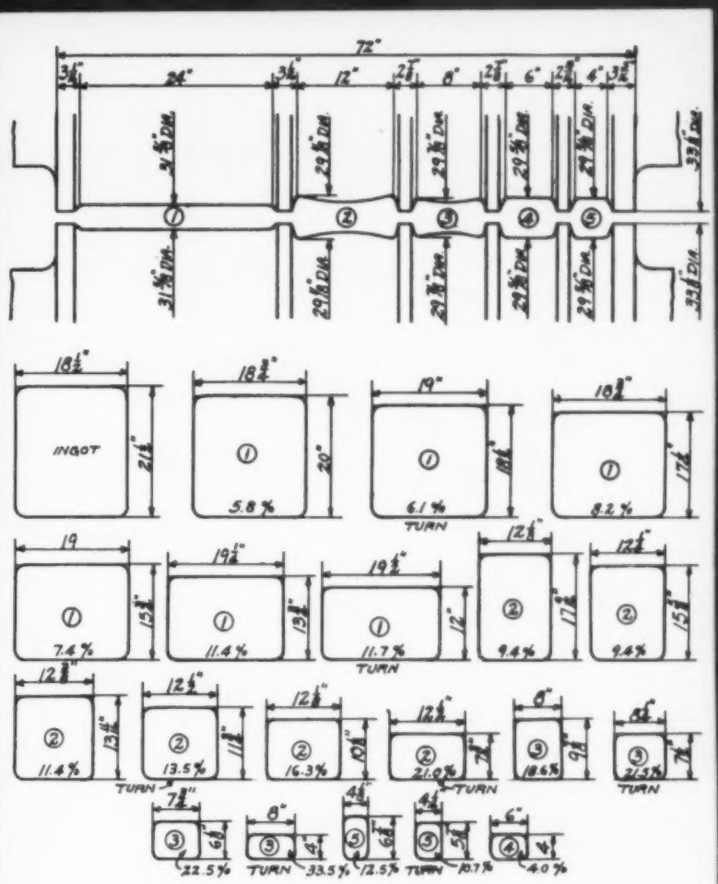
Spread is greater with rough rolls than with smooth rolls.

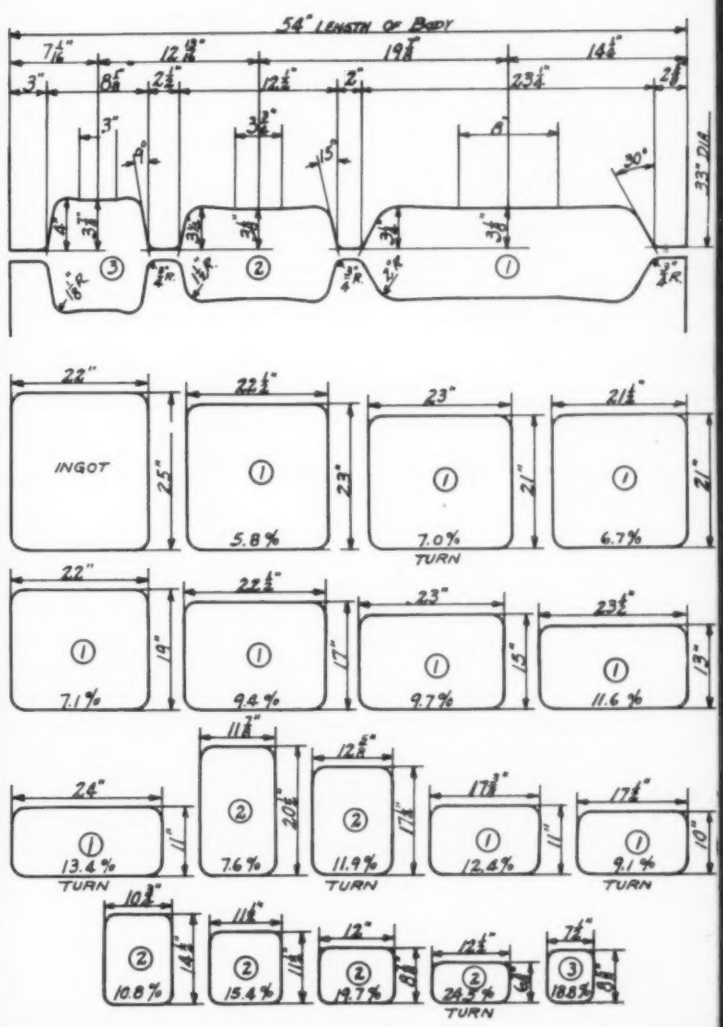
Spread is greater with large rolls than with small rolls.

Spread is greater with the narrower steel widths and deep sections. With wide, comparatively thin slabs and plates, no spreading occurs.

Spreading seems to increase as the steel temperature drops below 1850 F. Whether this is due to the lower temperature or to the increasing friction between steel and roll is not definitely known.

Spread depends on temperature distribution in the bar.





Figures 45 and 46 — Reduction schedules in blooming mills. The upper sketch is more typical of general practice. The lower method is designed for more definite entering and exit sizes.

If the steel is hotter at the center than at the surface, the middle spreads more than top and bottom. If the surface is hotter than the center, spreading at top and bottom of the steel is greater than at the middle.

The amount of spreading may range 23-40 per cent of the draft in the normal rolling of blooms. The following formula may be used for sections where the width is greater than the height:

$$\text{Spread} = k \times \frac{\text{Projected contact length}}{\text{Original thickness}}$$

where k = .3-.4. This formula gives too small a spread with heavy drafts. It is particularly low on edging passes, often giving only one-half of the actual spread. However, it must serve as an approximation, to be tempered by practical experience.

In cooling down from rolling temperatures to atmospheric temperature, steel shrinks approximately $\frac{1}{64}$ in. in one inch, or about 1½ per cent.

PRODUCTION RATES

Being directly connected to the drive motor, the reversing blooming mill runs at the same speed as the motor. The common range for blooming mills, 50-12 rpm, with the usual roll sizes, gives a basic mill speed of 400-550 fpm and maximum speeds ranging 950-1300 fpm. Several of the latest mills have maximum speeds of 952 fpm. In actual rolling, however, the mills seldom exceed 700 fpm, unless very long, light sections are being rolled. In fact, several plants have found that by limiting the mill speed to the basic figure — say 50 rpm, or about 400-500 fpm — the mill production was actually increased. This is because the ingot does not overtravel as far on each side of the mill between passes, and less time is therefore spent in manipulation between passes.

The relative effect of mill speed and manipulating time upon mill production can perhaps be brought out most forcibly by some tests recently made on several modern installations.

Oscillogram records and time studies taken at random on several slabbing mills furnish interesting comparisons of rolling practice. Figure 48 shows speed, load and pass record on a modern high lift blooming-slabbing mill while rolling a 26 in. x 47 in., 20,500 lb ingot to 4¼ in. x 40½ in. slabs, an elongation of 7.1. The chart shows that 159 sec were required to roll the ingot, including time between ingots, which is at the rate of 232 net tons of ingots per hr. This is not a maximum rate, as this same schedule has been rolled for sustained periods at a rate of 300 tons per hr. The durations of passes and of the intervals between passes are plotted in Figure 49. The effect of edging passes on the length of intervals is apparent. Steel was in the rolls 30 per cent of the total time. This figure increases to 35 per cent when rolling at a 300 ton per hr rate. This schedule does not make any severe demands on the electrical equipment, which includes a 7000 hp reversing motor and three 2500 kw, 700 volt generators. Maximum load registered was 11,500 amp which is only 45 per cent overload on the motor.

The loads and speeds of the horizontal and vertical drives of a universal slabbing mill while rolling a 29 in. x 55 in., 26,400 lb ingot to a 6 in. x 40 in. slab are shown in Figure 50. The elongation in this case is 6.65, and 125 sec were required to roll the ingot, including the time between ingots. This is at the high rate of 380 net tons of ingots per hr, and the maximum load on the horizontal rolls is 20,000 amp which is 175 per cent of full load on the 10,000 hp drive. The maximum load on the 3000 hp vertical roll drive was 8300 amp, or 236 per cent of full load. The duration of passes

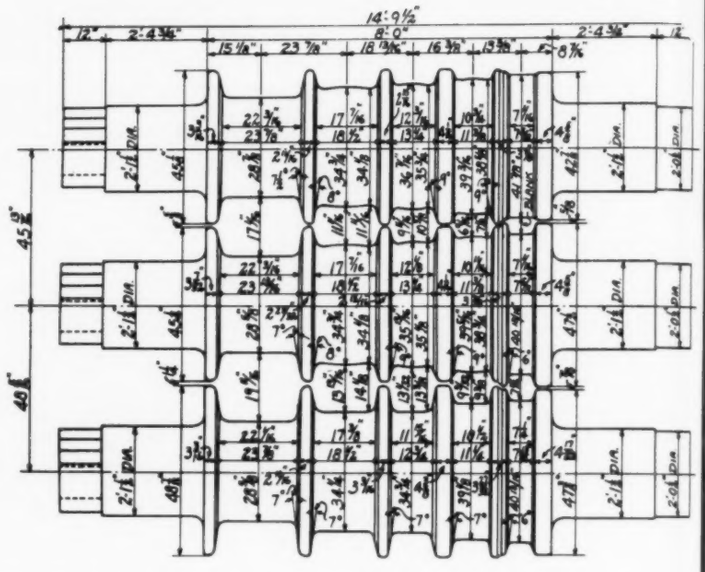


Figure 47 — Typical set of three-high blooming mill rolls. The fixed passes reduce flexibility and limit the mill to moderate elongations.

and intervals shown in Figure 51 indicate that steel was in the horizontal rolls 30 per cent of the time, and in horizontal or vertical rolls, or both, a total of 39 per cent. In this case, the first five passes were taken with the ingot on edge and no work was done in the vertical rolls.

Similar data on a modified universal mill, in which the vertical rolls are separated 33 ft. from the horizontal rolls, are given in Figures 52 and 53. The rolling schedule was 20 in. x 57 in., 17,000 lb ingots to 3½ in. x 63½ in. slabs. It will be noted that this schedule calls for spreading the ingot, accomplished in this installation by broadsiding the ingot, which is brought to the mill flat and never edged. The time required for rolling was 210 sec, giving a rate of 145 net tons per hr. The maximum load on the 10,000 hp horizontal roll drive was 10,500 amp or 92 per cent of full load, while the 2000 hp vertical roll drive hit a maximum of 2400 amp or 84 per cent. This mill is capable of higher tonnages, but is kept in step with a continuous strip mill to which the slabs move without storage. Steel was in the horizontal rolls 18.1 per cent of the total time and in the vertical rolls 5.1 per cent of the time. Reduction was accomplished by five passes in the horizontal rolls, edging in the vertical rolls, followed by

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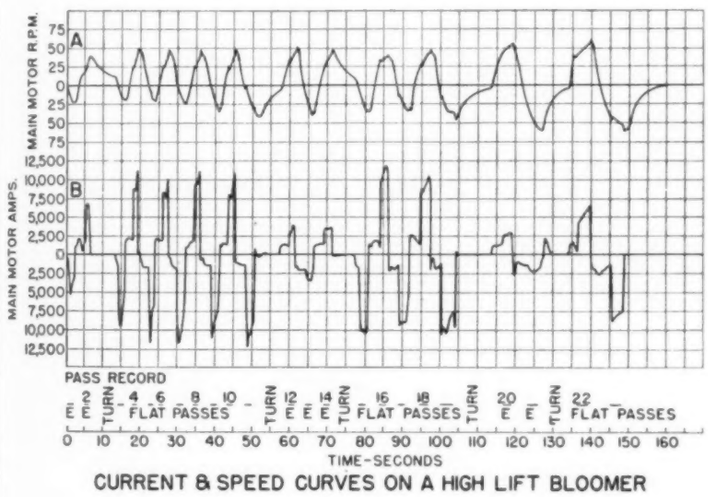
four broadside passes, and finally turned and finished by additional passes in vertical horizontal passes. Figure 52 shows the complete sequence of passes. On flat passes the maximum reductions were 1 in.

Rolling rates of blooming mills vary widely with the size of the mill, the drive power, and the product being rolled. The effect of mill size and drive capacity on rolling rates is indicated by the following approximations of average practice:

Mill size, in.	*Drive hp.*	*Tons per hr*
32-36	3750	50-60
36	5000	63-75
36	6500	65-87
40-44	7000	175-200

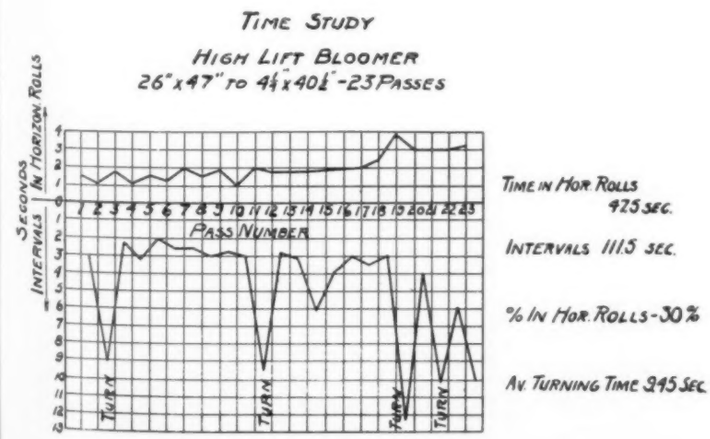
The degree of elongation also has a pronounced effect upon the rolling rate, as indicated by the curve in Figure 54. Light finished sections (or a high degree of elongation) reduce the tonnage to a marked degree. Some alloy steels require smaller reductions in each pass and consequently reduce the tonnage.

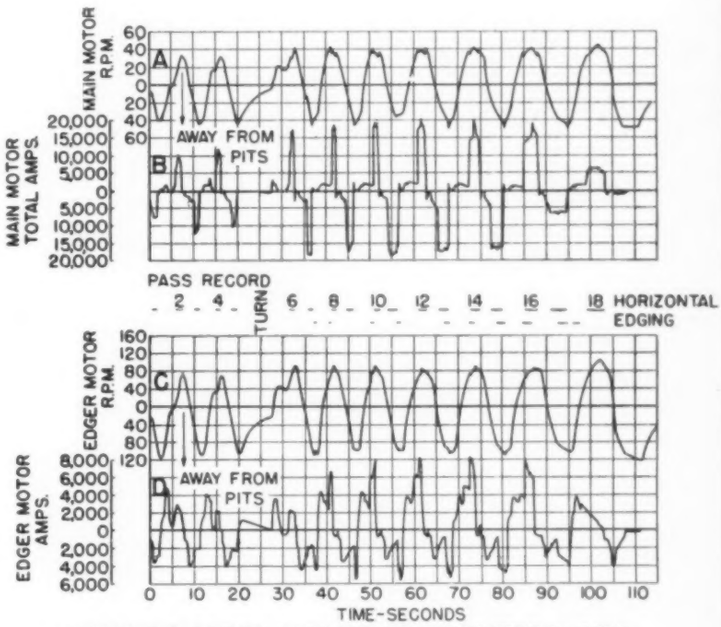
Even with the same degree of elongation, large ingots will give rolling rates considerably higher than those obtained with small ingots. The curves in Figure 55 shows a production rate for the smaller ingot of only about ¾ as much as obtained with the larger ingot. This may be accounted for by the fact that manipulation time for the larger ingot is not appreciably



CURRENT & SPEED CURVES ON A HIGH LIFT BLOOMER

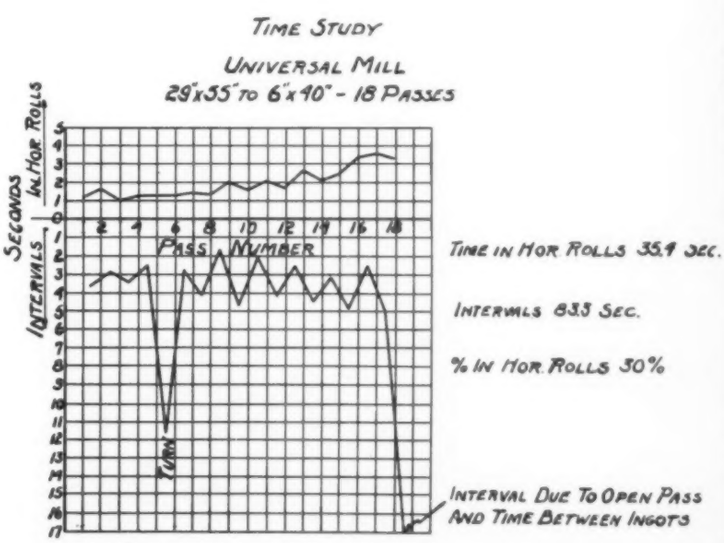
Figures 48 and 49 — The charts above and below show oscillogram record and time study curve of high-lift bloomer rolling a 26 in. x 47 in. 20,500 lb ingot to a 4¼ in. x 40½ in. slab.





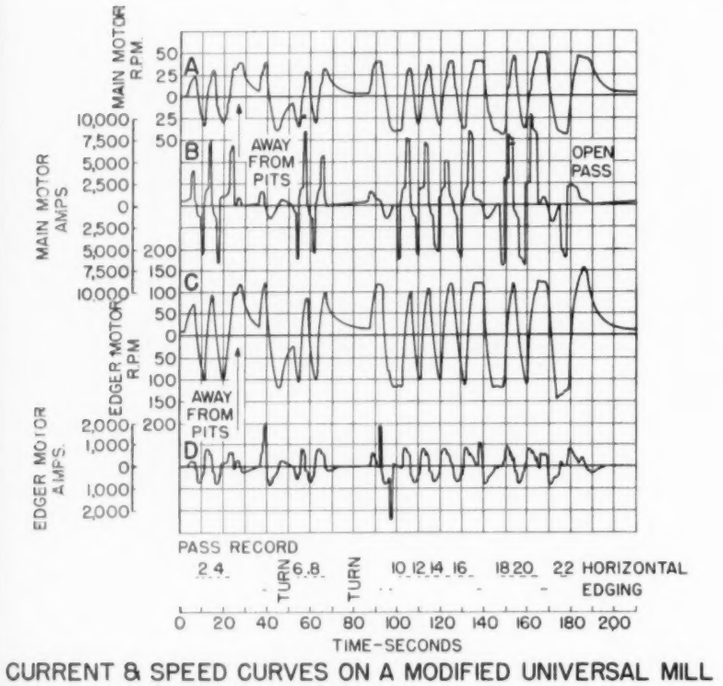
CURRENT & SPEED CURVES ON A UNIVERSAL MILL

Figures 50 and 51 — Oscillogram record (above) and time study chart (below) of reversing universal slabbing mill rolling 29 in. x 55 in., 26,400 lb ingots to 6 in. x 40 in. slabs.



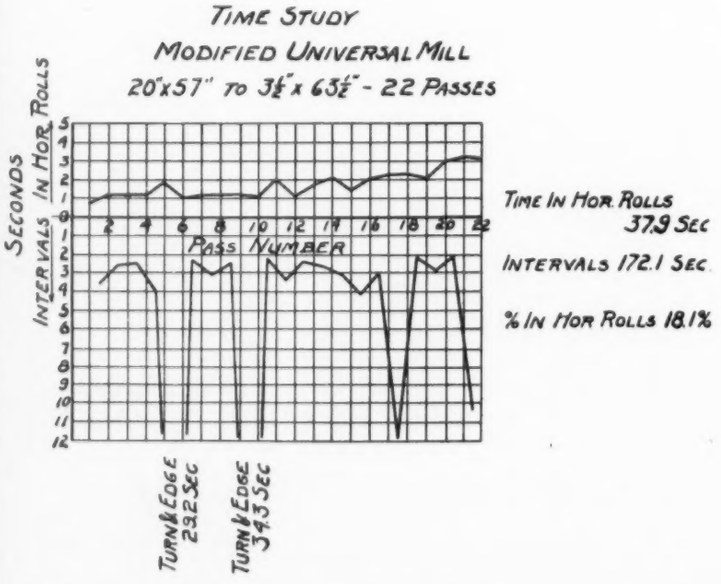
greater than for the smaller ingot, hence less time is lost per ton rolled.

Furthermore, the rolling rates for various lengths of rolling periods vary widely. For example, a mill may roll a single ingot at a rate of 300 tons per hr, or it may roll for one hour at a rate of 260 tons per hr, while the overall average hourly rate is perhaps 165 tons per hr. It has been estimated that the average rate of rolling for the modern mills is about 140 net tons per hr, although a number of mills maintain rates of 200 or more tons per hr. It has been further estimated that the overall average hourly rate is related to the maximum hourly rate in the ratio of .65 or .75. The maximum 24 hr day runs about 21 x the maximum hourly rate.



CURRENT & SPEED CURVES ON A MODIFIED UNIVERSAL MILL

Figures 52 and 53 — Records from modified universal slabbing mill while rolling 20 in. x 57 in., 17,000 lb ingots down to 3½ in. x 63½ in. slabs.


TIME STUDY
MODIFIED UNIVERSAL MILL
20"x57" TO 3½" x 63½" - 22 PASSES
SECONDS
INTERVALS IN HOR. ROLLS
PASS NUMBER
TIME IN HOR. ROLLS 37.9 SEC
INTERVALS 172.1 SEC.
% IN HOR ROLLS 18.1%
TURN & EDGE 29.2 SEC
TURN & EDGE 34.3 SEC

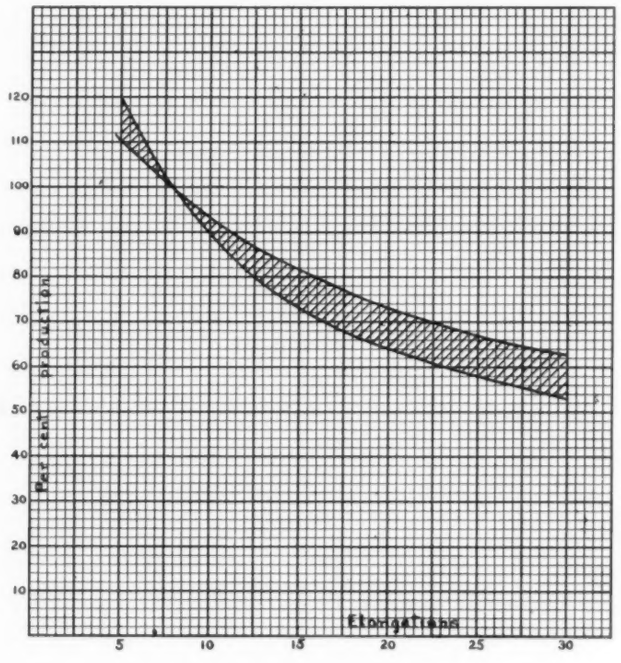
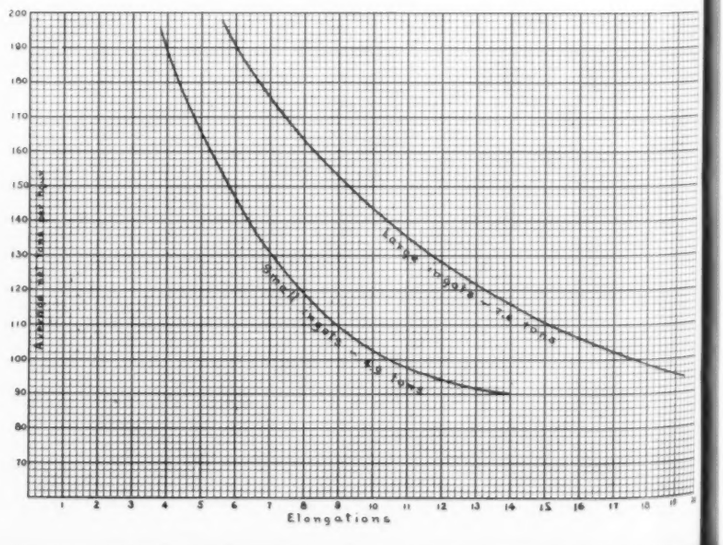


Figure 54 — Variation of production rate (per cent) with different elongations. Eight elongations are here taken as the base.

▲

Figure 55 — Production figures show greater tonnage rates from large ingots than from small ingots, even with the same degree of elongation.



Monthly production records on blooming mills have been made ranging as high as 171,000 net tons.

One mill reports an average rate of 155 tons per hr, with 60 per cent of the product to blooms ranging 6-11 in., and 40 per cent to slabs ranging 4-6 in. in thickness and 11-53 in. in width.

POWER REQUIREMENTS AND ROLLING PRESSURES

The power required for rolling steel in the blooming mill depends on the size and shape of the ingot and of the rolled product, the analysis and temperature of the steel, the roll size, and the efficiency of the mill machinery, which in turn depends on bearings, lubrication, etc. The greater the degree of elongation, the higher the power consumption, in the relation shown by the curve in Figure 56, which shows the total consumption of the main drive. Another 6-10 kwhr per ton is used by the mill auxiliaries. Likewise, more power is required as the carbon or alloy content of the steel increases, or as the steel temperature decreases. The power for a medium carbon steel will run 10-20 per cent higher than for mild steel, while a high carbon or alloy steel may require 20-50 per cent more power than mild steel. The effect of steel temperature is indicated by the curves in Figure 57. As the temperature of the steel drops during rolling to the extent of 400-700 F, the increase in power for the later passes is significant.

Of the power input to the blooming mill drive, only 58-60 per cent is used in deforming the steel and overcoming the increased friction losses incident to the rolling. An approximate distribution of the power input is as follows:

Power required for rolling	59.00
Friction of pinions and mill	5.90
Loss in reversing motor	10.84
Loss in electrical connections	.75
Loss in generators	11.44
Loss in flywheel	1.32

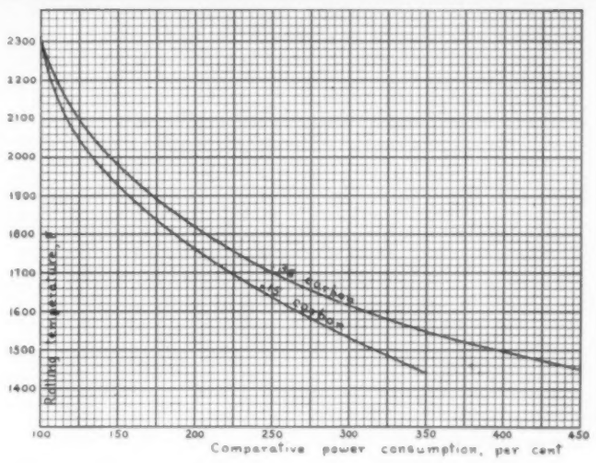


Figure 57 — Temperature of the steel rolled has a very marked influence on power consumption, as indicated here.

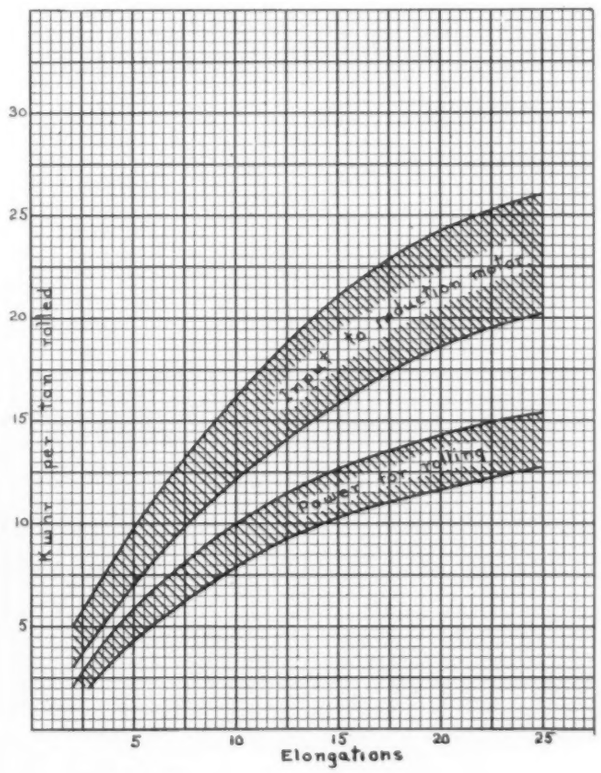
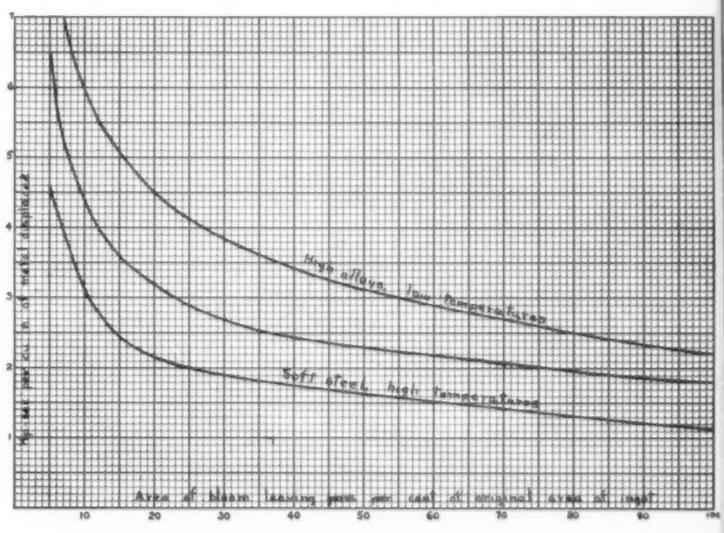


Figure 56 — (Left) Curves showing variation of power consumption with increased elongation of the ingot.

▲

Figure 58 — (Below) Curves giving specific power for motor torque for displacement of metal plus all increases in friction during the pass.



Loss in slip regulator	2.69
Loss in induction motor	6.40
Loss in exciters, blowers, etc.	1.66
	100.00

The power required for rolling in the blooming mill may be approximated from the formula:

$$T = 275 \times C\ (A_1 - A_2) \times D \times \frac{A_2}{A_1}$$

where T = motor torque, lb-ft
C = a factor from Figure 58
A_1 = area of section before pass, sq in.
A_2 = area of section after pass, sq in.
D = diameter of roll at base of pass, in.

The curves in Figure 58 are based on test data, and show specific values of hp-sec per cu in. of metal displaced against the bloom area after the pass, expressed as a percentage of ingot area. These values are for motor torque for displacement of metal plus all increases in friction during the pass. As might be expected from the previous discussion of the factors effecting power consumption, values vary widely and thus we have three curves in Figure 58. For general use, the middle curve should be used, the higher curve giving values for extreme cases of analysis, temperature, etc., and the lower curve holding for uniformly favorable conditions.

The rolling schedule must be calculated pass by pass, adding in the idling friction torque which may average 20,000-25,000 lb-ft.

To obtain maximum torque, it is necessary to add in the torque required for acceleration. The inertia of mill parts, rolls, ingot and armature for a 44 in. mill driven by a 7000 hp motor is about 4,250,000 lb-ft² (approximately 1,900,000 for the mill, etc., and 2,350,000 for the armature). If rates of acceleration and deceleration are taken at 20 rpm per sec and 40 rpm per sec, respectively, accelerating torque is:

$$Ta = \frac{.003255 \times Wr^2 \times rpm}{t}$$

$$= \frac{.003255 \times 4{,}250{,}000 \times 20}{1}$$

$$= 276{,}000 \text{ lb-ft}$$

Torque for deceleration is found, in the same manner, to be 552,000 lb-ft. Torques for acceleration and deceleration modify the torque for rolling and friction, the former being an additional torque during the period the motor speed is increasing after the steel is in the rolls. As deceleration starts before the steel leaves the rolls, the torque due to the inertia of armature and mill parts is then available for displacement of metal and the current demand is decreased. As soon as the steel leaves the rolls, a torque must be further modified by multiplying the maximum torque values by the ratio of actual speed to basic speed, obtaining an "equivalent maximum torque" which is used only in determination of the heating of the motor. To determine the capacity of the motor it is necessary to calculate the root-mean-square torque.

$$T_{r.m.s.} = \sqrt{\frac{(T_1)^2 t_1 + (T_2)^2 t_2 + \ldots\ldots + (T_n)^2 t_n}{t_1 + t_2 + \ldots\ldots + t_n}}$$

where t = time for which respective torques prevail. The r.m.s. of the positive torques and of the negative torques are calculated separately, and their values added arithmetically. Then

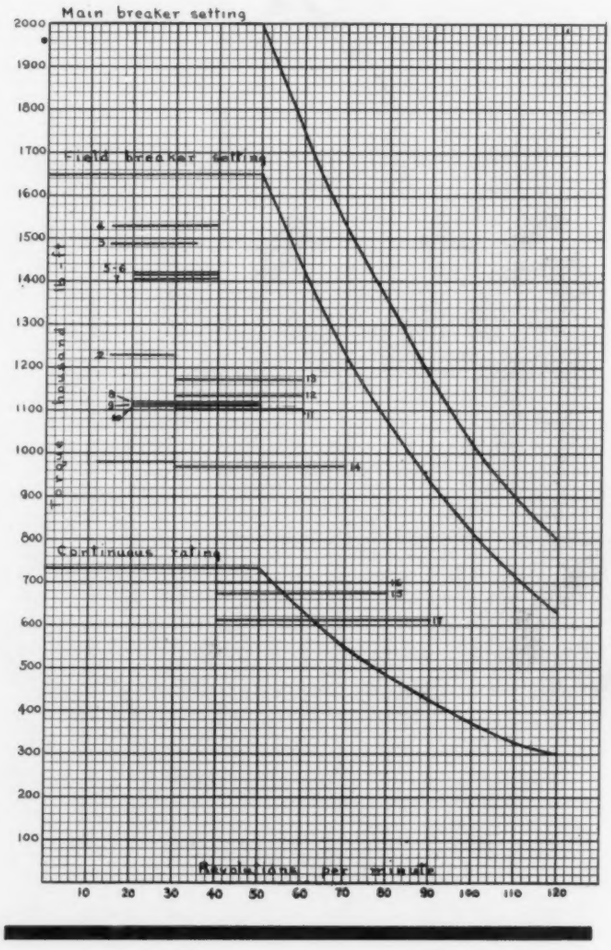
$$hp = \frac{T_{r.m.s.} \times \text{basic rpm}}{5250}$$

This value, representing the heating value, may be about twice the average net output of the drive.

Thus, the reversing motor must meet two requirements. It must meet the pass-by-pass torque requirements of the schedule, and it must meet the heating effect of the schedule. Table V gives a rolling schedule and torque calculations for reducing 24 in. x 29 in. ingots to 8 in. x 8 in. blooms in a 44 in. reversing mill. (Spreading is omitted in this schedule for the sake of simplicity.) Columns 1-24 in the table cover the calculations as given in the foregoing discussion.

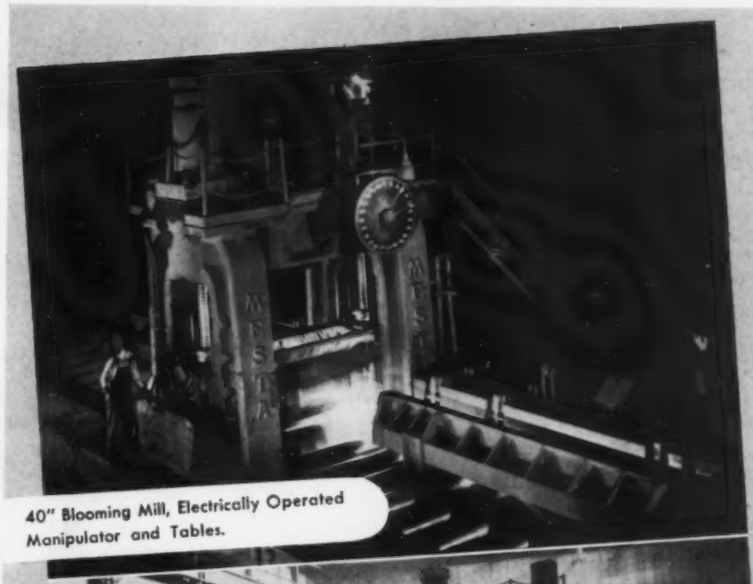
The root-mean-square torque for the schedule given in Table V works out to about 750,000 lb-ft, and the motor capacity is therefore 750,000 x 50 ÷ 5250 = 7150 hp. Thus a 7000 hp motor would be adequate from the heating standpoint, as it would be impossible to maintain continuously the high rate of rolling given in the

Figure 59 — Chart showing motor torque of rolling schedule as calculated in Table V.



MESTA

BLOOMING AND SLABBING MILLS



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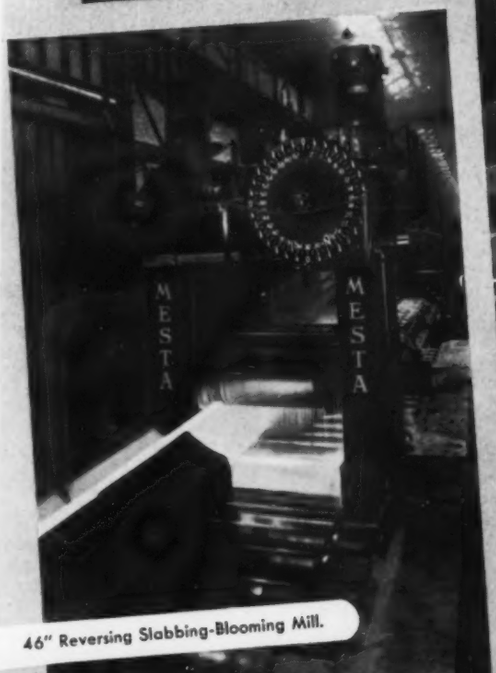

46" Reversing Slabbing-Blooming Mill.

46" Reversing Slabbing-Blooming Mill with Manipulators and Tables.

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TABLE V — Rolling Schedule and Torque Calculations for Blooming Mill

(29 in. x 24 in., 15,400 lb ingot to 8 in. x 8 in. blooms)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pass	Width in.	Depth in.	Area, sq in.	Per cent red'tion	Length, in.	Roll dia., in.	Total revol's	Roll speed			Rolling time in pass, sec.			
								Enter	Run	Delivery	Accel'n	Run	Decel'n	Total
0	24	29	696	....	83	....	....	....	....	....	....	....	....	....
1	24	27.5	660	5.2	88	40	.69	12	30	25	.9	.64	.12	1.66
2	24	25.5	612	7.3	95	40	.75	15	30	25	.75	.82	.12	1.69
3	24	23.0	552	9.8	104	40	.83	15	35	25	1.0	.50	.25	1.75
4	24	20.5	492	10.8	116	40	.93	15	40	30	1.25	.30	.25	1.80
Turn														
5	20.5	21.5	440	10.5	129	40	1.05	20	40	30	1.0	.62	.25	1.87
6	20.5	19.0	390	11.4	149	40	1.23	20	50	40	1.5	.20	.25	1.95
Turn														
7	19	18.0	342	12.3	170	40	1.37	20	50	40	1.5	.37	.25	2.12
8	19	16.0	304	11.1	190	40	1.54	20	50	40	1.5	.57	.25	2.32
9	19	14.0	266	12.5	216	40	1.78	20	50	40	1.5	.86	.25	2.61
10	19	12.0	228	14.2	253	35	2.30	20	60	50	2.0	.73	.25	2.98
Turn														
11	12	16.0	192	15.8	302	35	2.72	30	60	50	1.5	1.4	.25	3.15
12	12	13.0	156	18.8	372	35	3.36	30	60	50	1.5	2.0	.25	3.75
13	12	10.0	120	23.0	485	35	4.30	30	60	50	1.5	2.95	.25	4.70
14	12	8.0	96	20.0	600	35	5.36	30	70	60	2.0	2.95	.25	5.20
Turn														
15	8	10.5	84	12.5	690	35	6.20	50	90	70	2.0	2.16	.5	4.66
16	8	9.0	72	14.2	800	35	7.10	50	90	70	2.0	2.76	.5	5.26
17	8	8.0	64	11.1	900	40	7.20	50	100	90	2.5	2.25	.25	5.00

1	16	17	18	19	20	21	22	23	24
Pass	Seconds between passes	Total accumulative seconds	Per cent original area	C (from curve)	$A_1—A_2$	A_2/A_1	Rolling and friction torque, lb-ft	Maximum torque, lb-ft	Equivalent maximum torque, lb-ft
0	10.0	.....	.....	.....	.....	.....	.....	.....	.....
1	2.0	11.66	95	1.8	36	.95	702,000	978,000	.....
2	3.0	15.35	88	1.9	48	.93	957,000	1,233,000	.....
3	2.0	20.10	80	2.0	60	.90	1,212,000	1,488,000	.....
4	3.0	23.90	71	2.1	60	.89	1,252,000	1,528,000	.....
Turn									
5	2.0	28.77	63	2.2	52	.89	1,142,000	1,418,000	.....
6	3.0	32.72	56	2.3	50	.89	1,142,000	1,418,000	.....
Turn									
7	2.0	37.84	49	2.4	48	.88	1,132,000	1,408,000	.....
8	2.5	42.16	44	2.4	38	.89	910,000	1,186,000	.....
9	2.5	47.27	38	2.5	38	.88	940,000	1,216,000	.....
10	5.0	52.75	33	2.6	38	.86	840,000	1,116,000	1,400,000
Turn									
11	3.0	60.90	28	2.8	36	.84	840,000	1,116,000	1,340,000
12	3.0	67.65	22	3.0	36	.81	862,000	1,138,000	1,360,000
13	3.0	75.35	17	3.3	36	.77	900,000	1,176,000	1,410,000
14	5.0	83.55	14	3.6	24	.80	690,000	966,000	1,350,000
Turn									
15	4.0	93.21	12	3.8	12	.87	400,000	676,000	1,220,000
16	4.0	102.47	10	4.0	12	.86	422,000	698,000	1,260,000
17	....	111.47	9	4.0	8	.89	336,000	612,000	1,220,000

table. Plotting the torques pass by pass in Figure 59 shows that the 7000 hp motor is also adequate from that standpoint. If the torque cycle is plotted and integrated, it is found that the average net mechanical output of the reversing motor is only 3520 hp, or about half of the required continuous capacity of the motor.

Columns 25 and up in Table V are calculations based on the compressive strength of the steel, as used by W. Trinks in his books on "Roll Pass Design". Formulae are as follows:

Projected contact length = $\sqrt{R\,(h_1 - h_2)}$

Projected contact area = projected contact length x width of the bloom.

$$\text{Rate of compression} = \frac{.105\ x\ n\ \sqrt{R\,(h_1 - h_2)}}{h_1}$$

Compression resistance is read from curves in Figure 60.

Separating force = compression resistance x contact area

Lever arm = ½ of projected contact length

Rolling torque = $\frac{2 \text{ x separating force } x \text{ lever arm}}{12}$

In the above, R = roll radius, in.
h_1 = depth of bloom, in., before pass
h_2 = depth of bloom, in., after pass
n = rpm of rolls

It is to be noted that this rolling torque includes no friction torque, but only that for deforming the steel. It should be multiplied by 1.6 or 1.7 to obtain motor torque. Even then, comparison of columns 22 and 33 shows a considerable variation and gives warning that the basic data used in calculations of this sort must be chosen with extreme care.

The separating forces given in column 30 are the mechanical stresses to which the mill housings, bearings, etc., are subjected. If desired, they can be calculated from the torques given in column 22 using the formula:

$$P = \frac{12\ x\ T}{\sqrt{R\,(h_1 - h_2)} + fd}$$

where P = separating force, lb
T = rolling and friction torque, lb-ft

$\sqrt{R\,(h_1 - h_2)}$ = projected contact length, in., as previously discussed

f = coefficient of friction (.08-.10 for babbitted bearings)

d = diameter of roll neck, in.

This formula may be simplified for approximate work, by the use of certain average figures, to the following:

$$P = \frac{7.8\ T}{\sqrt{R(h_1 - h_2)}}$$

Pressures calculated from this formula and the torques of column 22 are shown in column 34, and comparison with those given in column 30 again show considerable variation, particularly in the first several passes.

One factor tending to prevent agreement of the separating forces calculated by the two methods is the tendency of the steel to squeeze backward from the rolls and "pile up" just before entering between them. This has the effect of increasing the projected contact length, and consequently, the projected area and the lever arm. Thus, separating forces calculated from the resistance to compression would be increased because of the increased contact area, while forces calculated from motor torque would be decreased because of the increased lever arm. Hence, the true separating force probably lies between the two calculated values. As a rough approximation, with common steel, pressures range from 40,000 lb per in. of steel width in the early passes up to 80,000 lb per in. of width in the later passes. The total separating force therefore becomes quite large in the slabbing mills rolling the greater widths.

1	25	26	27	28	29	30	31	32	33	34
Pass	Projected contact length, in.	Projected contact area, sq in.	Temp. of bloom, F.	Rate of compression	Compression resistance, psi	Separating force, lb	Lever arm, in.	Rolling torque, lb-ft	Torque × 1.7	Separating force, lb, (from Col. 22)
0	.....	.....	2250	.....	.....	.....	.....	.....	.....	.....
1	5.5	132	2200	.65	5,000	640,000	2.75	293,000	498,000	1,000,000
2	6.32	152	2200	.725	5,200	790,000	3.16	416,000	707,000	1,180,000
3	7.08	170	2190	1.02	5,800	985,000	3.54	581,000	988,000	1,340,000
4	7.35	176	2180	1.033	6,000	1,055,000	3.68	650,000	1,105,000	1,325,000
Turn										
5	7.08	145	2170	1.23	6,500	942,000	3.54	557,000	948,000	1,260,000
6	7.75	159	2160	1.89	7,300	1,160,000	3.88	750,000	1,275,000	1,150,000
Turn										
7	7.08	135	2140	1.95	8,000	1,080,000	3.54	638,000	1,085,000	1,245,000
8	6.32	120	2120	1.84	8,200	960,000	3.16	505,000	859,000	1,120,000
9	6.32	120	2100	2.07	8,500	1,020,000	3.16	539,000	916,000	1,160,000
10	5.9	112	2080	2.65	9,700	1,085,000	2.95	532,000	905,000	1,110,000
Turn										
11	7.25	87	2060	2.4	10,000	870,000	3.63	527,000	896,000	903,000
12	7.25	87	2040	2.85	10,800	940,000	3.63	570,000	970,000	925,000
13	7.25	87	2010	3.5	12,500	1,087,000	3.63	660,000	1,120,000	968,000
14	5.9	71	1980	4.56	15,000	1,060,000	2.95	522,000	888,000	912,000
Turn										
15	5.1	41	1950	4.03	14,800	605,000	2.55	257,000	436,000	610,000
16	5.1	41	1920	4.6	16,500	675,000	2.55	287,000	488,000	645,000
17	4.46	36	1890	5.2	18,200	655,000	2.23	243,000	413,000	590,000

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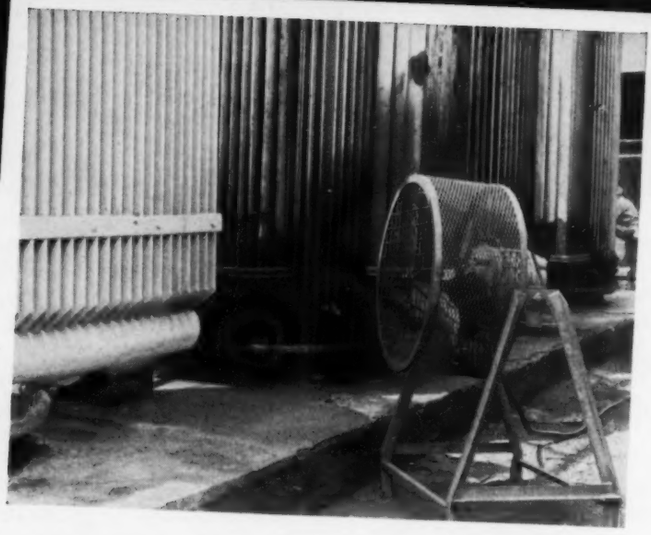

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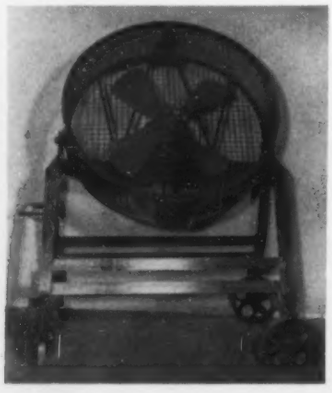

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BLOOMING MILL DRIVES

It is perhaps indicative of the age of many of the blooming mills that about one-half of them are driven by steam engines. Since the application of the electric drive in 1913, there have been relatively few engine drives installed on blooming mills in the United States. A number of engines have been replaced by motors on existing mills. It is, however, difficult to economically justify scrapping an engine and installing an electric drive on an old mill. Thus it is that we find the engines still performing creditable work — in fact, setting new records. However, to forestall the thought that this is an attempt to revive the long-to-be-remembered steam vs. electric arguments, it should be stated that the electric drive is the only one seriously considered in a blooming mill installation today.

The main drive motor for reversing service is of rugged construction, with the frame of cast steel or rolled, welded steel, horizontally split. The pedestal bearing of the motor next to the mill is of cast steel and provided with a thrust bearing. Pole pieces for both the main poles and the interpoles are laminated to give maximum magnetic qualities. The rotor spider is of cast or fabricated steel. The commutator is usually built up on a ring which is attached to the armature spider. The effects of armature reaction are fully corrected by the use of interpoles and compensating windings. In recent years single-armature motors seem to be preferred to the older double-armature design, and have been developed in sizes up to 8000 hp, 40-100 rpm. Larger drives bear toward the twin-motor type.

Speed variation in the reversing motor is obtained over the lower range by control of armature voltage. Over the higher portion of the range, field weakening is used, with a resultant dropping off of torque. The basic speed is that corresponding to full voltage on armature and field, and is usually set at 40-50 rpm. Speed ranges of 0-50-120 seem to be in the majority. Actually, the maximum speed attained in operation is seldom beyond 65 rpm. The selection of basic speed is important, in that it influences the available torque. Constant operating torque = hp x 5250 ÷ base rpm.

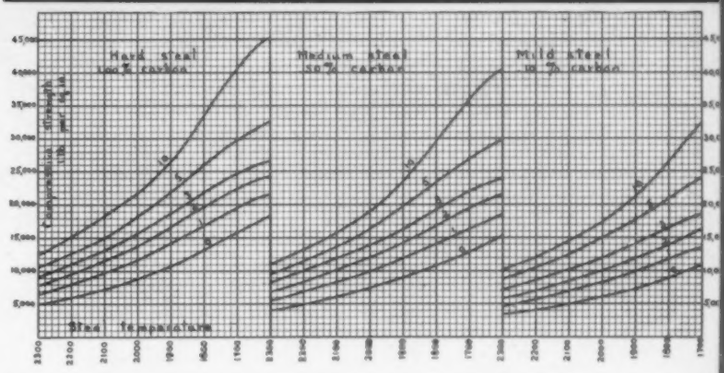
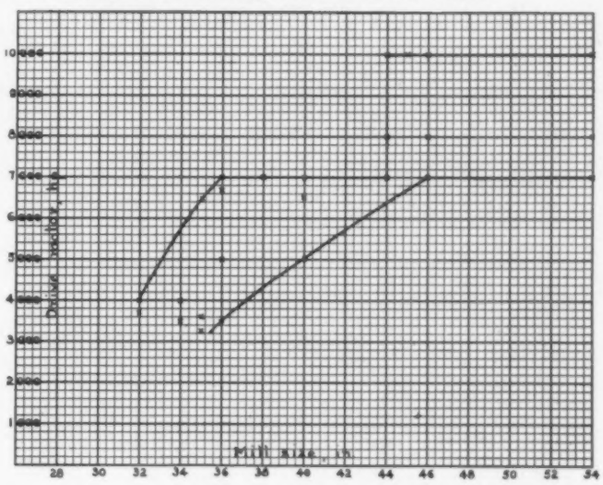


Figure 60 — Chart giving resistance to compression of various types of steel at varying temperatures and rates of compression.

Figure 61 — Chart showing reversing drive motor hp as installed on blooming mills of various sizes.

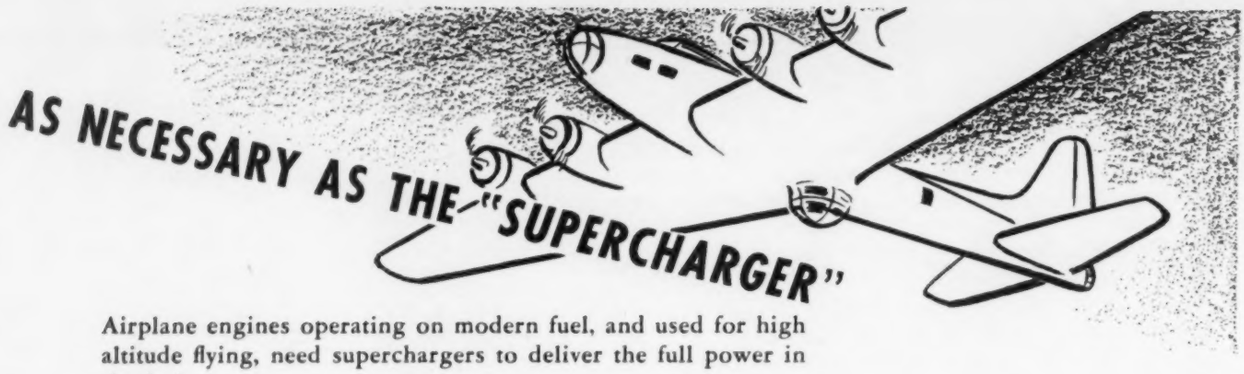


In standard drives, field relay settings are put at 2.25 times the constant operating torque, and main breaker settings at 2.75 times the constant operating torque.

Rated d-c voltages in the newer reversing drives are

TABLE VI — Reversing Drive Motors

Motor hp	3750	5000	6350	7000	8000	10,000
Motor rpm	0-50-120	0-50-120	0-60-120	0-50-120	0-40-80	0-40-80
Continuous rating torque, lb-ft	395,000	525,000	557,000	735,000	1,050,000	1,310,000
Max. torque, field breaker, lb-ft	890,000	1,185,000	1,250,000	1,660,000	2,300,000	2,950,000
Max. torque, main breaker, lb-ft	1,090,000	1,450,000	1,535,000	2,020,000	2,890,000	3,600,000
Generator capacity, kw	2 x 1800	2 x 2200	2 x 2700	2 x 3000 3 x 2500	2 x 3500 3 x 2500	3 x 3000
M-G set drive, hp	3000	3650	4350	5000-6000	5000-6000	6500-7500
M-G set drive, rpm	514	514	400	360	360	360
Flywheel diameter, ft-in.	13-0	13-0	14-6	15-0	15-0	15-0
Flywheel weight, lb	75,000	75,000	100,000	110,000	150,000	180,000
Flywheel WR², lb-ft²	1,650,000	1,650,000	2,700,000	3,200,000	4,300,000	5,200,000
Flywheel stored energy, hp-sec	135,000	135,000	134,000	130,000	175,000	210,000



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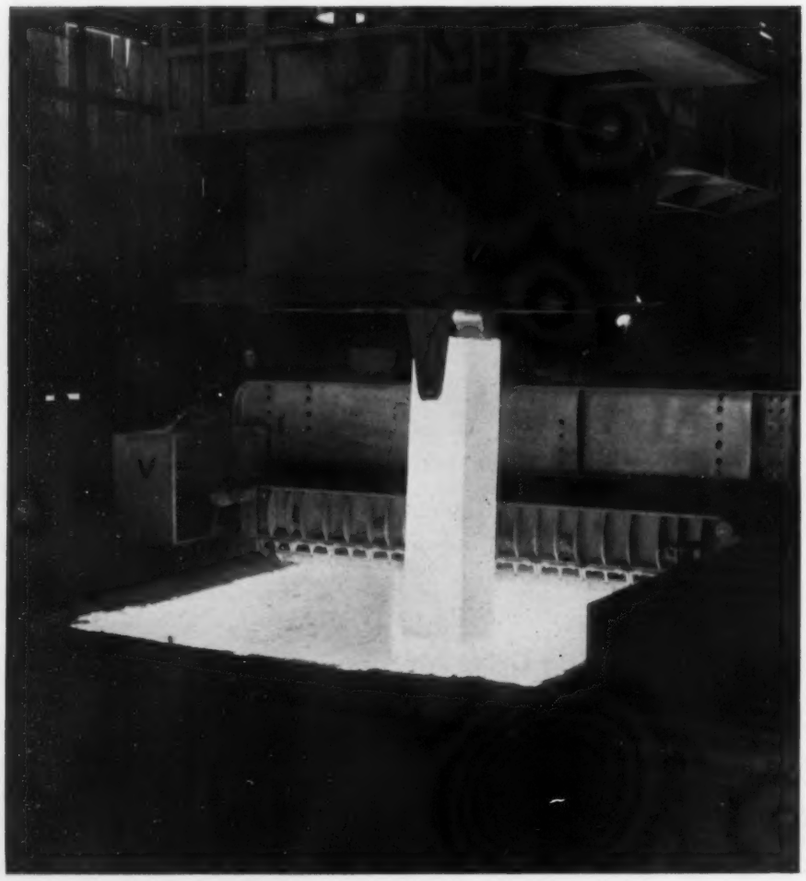

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700-750 volts, although the tabulation of mills (Table II) shows a range of 600-900 volts. Field circuits and control circuits are usually of 230 volts.

In Table II, it is to be noted that main drive motors range from 1500 hp to 10,000 ph. Modern practice narrows the range from 4000-10,000 hp, either shunt or compound wound and shows a general increase in drive capacity for a mill of given size. Figure 61 shows the relationship between motor rating and mill size. The line forming the upper limit is typical of modern practice unless a moderate capacity, with low first cost, is desired. Table VI gives data for drives as used in modern practice.

Motor selection is of course based on the rolling schedules to be met by the mill under consideration, but mill practice has gradually crystallized into such form as to make motor application dependent to a great extent on mill size, using previous installations as a guide. It is desirable, however, that the rolling schedules be analyzed and torques determined for each pass, motor size then being determined from the root-mean-square torque for the schedule. Many of the more recent installations (running 40-46 in. in size) have adopted the 7000 hp drive, which seems to meet the requirements of modern rolling practice. In fact, this drive has been so widely used as to be almost standardized. Some characteristics of a typical 7000 hp drive motor are approximately as follows:

Frame diameter, in.	197
Armature diameter, in.	148
Length of shaft, in.	295
Diameter of shaft, in.	32
Weight, lb.	416,500

Approximate reversing cycles: 50-50 rpm in 2 sec.; 120-120 rpm in 5 sec.

In all cases, the reversing motor receives power from a single flywheel motor-generator set. Generator capacity must be slightly greater than the motor capacity, because of the fact that the generators must supply

TABLE VII — Blooming Mill Drive Data

Company	Carnegie-Illinois Steel Corporation					Republic
Plant	South Works	South Works	South Works	South Works	Gary	Gadsden
Mill size, in.	54	40	44	35	44	40
Mill type	Bloomer	Bloomer	Slabber	Bloomer	Bloomer	Bloomer
Operating torque	2,950,000	1,660,000	2,950,000	1,225,000	2,300,000	1,660,000
Maximum torque	3,600,000	2,020,000	3,600,000	1,575,000	2,890,000	2,020,000
Horsepower, main drive	②5000	7000	②5000	6500	8000	7000
Horsepower, vert. roll drive	.....	.....	2500	.....	.....	.....
Arrangement, main drive	Twin drive	Single	Twin drive	Single	Single	Single
Voltage, main drive	700	750	700	700	800	700
Speed, main drive	40–80	50–120	40–80	60–140	40–80	50–120
Generators	③3000	②3000	③3500	②3000	②3500	②3000
Generator connections	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Motor-generator speed	368	375	368	368	375	352
Flywheel weight, lb	180,000	100,000	180,000	125,000	.....	140,000
Flywheel diameter, ft-in.	15–0	.....	15–0	15–0	.....	15–0
Flywheel construction	Steel plate	.....	Steel plate	Steel plate	.....	Steel plate
M. G. set drive, hp	6500	5000	6500	5000	6000	5000
M. G. set drive, frequency	25	25	25	25	25	60
M. G. set drive, voltage	2200	2200	6600	2200	6600	6600

Company	Youngstown Sheet and Tube	International Harvester	Bethlehem Steel Company			Wheeling Steel Corp.
Plant	Campbell	Wisconsin Steel	Lackawanna	Lackawanna	Sparrows Point	Steubenville
Mill size, in.	44	40	54	44	40	45
Mill type	Bloomer	Bloomer	Bloomer	Bloomer	Slabber	Slabber
Operating torque	1,660,000	1,660,000	1,900,000	1,660,000	2,150,000	1,660,000
Maximum torque	2,020,000	2,020,000	2,400,000	2,020,000	2,700,000	2,020,000
Horsepower, main drive	7000	7000	7000	7000	7000	7000
Horsepower, vert. roll drive	.....	.....	.....	.....	2500	1650
Arrangement, main drive	Single	Single	Single	Single	Single	Single
Voltage, main drive	700	700	750	750	650	750
Speed, main drive	50–120	50–120	40–80	50–120	50–100	50–100
Generators	②3000	②3000	②3000	②3000	③3000	③2400
Generator connections	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Motor-generator speed	352	352	375	375	375	400
Flywheel weight, lb	140,000	100,000	100,000	130,000*	.....	100,000
Flywheel diameter, ft-in.	15–0	14–5	15–3	15–6*	.....	.....
Flywheel construction	Steel plate	Cast steel	.....	Cast steel*	.....	.....
M. G. set drive, hp	5000	4000	5000	8000*	6000	5000
M. G. set drive, frequency	60	60	25	25	25	60
M. G. set drive, voltage	6600	2200	6600	6600	6600	6600

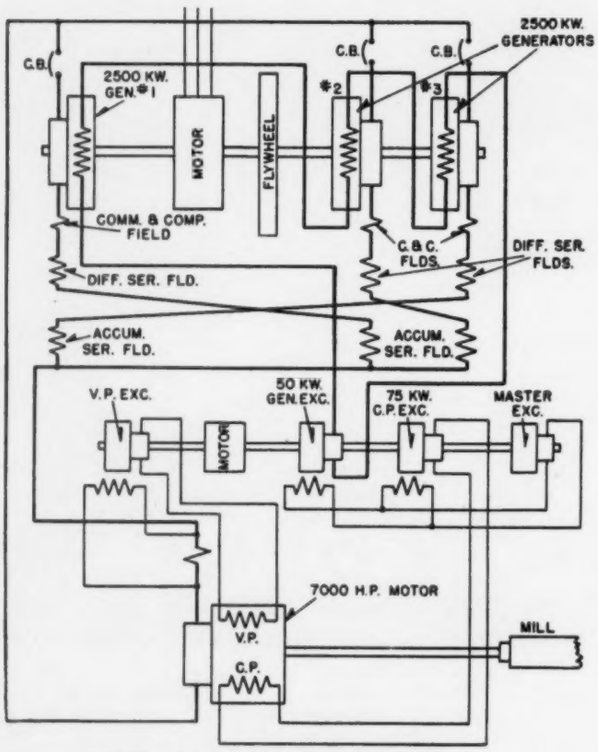
*Also ②2200 kw generators on this set for rail mill.

the motor losses. At least 10 per cent capacity should be added to the generator equivalent of the motor rating, and an extra margin is usually desirable. Most of the 7000 hp reversing motors are supplied from 6000 kw generator capacity, with one modern unit using 7500 kw capacity. A ratio of generator capacity to reversing motor capacity of 1.15 to 1.35 is found, with most installations toward the lower value.

The induction motor driving the motor-generator set should have a capacity ample to take care of the average net power output of the drive motor (which may be only about 50 per cent of its heating load capacity), plus the electrical losses of motor, generators, and slip regulator, plus the friction and windage of the flywheel. Past experience has indicated this motor to have a root-mean-square load of about 1.1 times its average load. Thus, the induction motor is found to have a capacity of about 1.5 times the average net output of the reversing motor. In practice, the motor-generator sets are usually proportioned as follows:

Generator capacity, kw	*Induction motor, hp*
6000	5000
7500	6000
9000	7000
10500	7500

Figure 62 — In this single motor reversing drive, power is supplied from three 2500 kw generators in parallel.



SCHEMATIC CONNECTIONS FOR SINGLE MOTOR BLOOMING MILL DRIVE

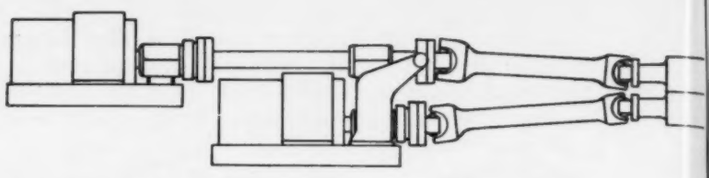


Figure 63 — Sketch showing arrangement of twin-motor drive.

From this, a ratio of generator capacity to induction motor capacity of .55-.65 is noted, although it is dangerous to use a ratio such as this without investigating the rolling schedule and determining the actual duty cycle.

The motor generator sets are also provided with a flywheel, usually of steel plate construction, hot riveted. Dimensions and weights of flywheels are shown in Tables VI and VII. A diameter of 15 ft. seems to be usual for the newer units, with weights ranging 140,000-200,000 lb. Steel plate flywheels may be driven at peripheral speeds of about 22,000 fpm. A slip of 15 per cent, which will render about 30 per cent of the flywheel energy available, is considered the maximum desirable.

So that full benefit of the flywheel is obtained, a slip regulator is provided for the induction motor-generator set drive. A torque motor responds to the current in the primary circuit of the induction motor, acting to raise and lower the electrodes of the slip regulator. At loads below the selected value, the torque motor cannot lift the electrodes from their bottom position. At loads above this value, the torque motor acts to separate the electrodes, introducing resistance in the secondary circuit of the motor, slowing it down and shifting excess load to the flywheel. Slip regulators are generally set to restrict the input to the induction motor to some value between 125 and 175 per cent of full load input. The slip regulator is also used as a starting resistor.

Modern installations usually employ dynamic braking to stop the motor-generator set. In doing this, the primary winding of the induction motor is disconnected from the a-c supply, and is energized from a low voltage d-c source while the slip regulator electrodes are widely separated. A small low voltage exciter may be added to the exciter set to supply the braking current. Dynamic braking is preferable to the old practice of plugging the induction motor with the slip regulator electrodes at maximum separation.

Figure 00 is a schematic diagram of main and field connections of a single motor reversing drive. In this case, the single armature reversing motor is supplied with power from three 2500 kw generators in parallel. In order to assure equal load dividion between the generators each is provided with a cumulative and differential series field. Each differential field is in series with its own armature. Each cumulative field is in series with the armature of the preceding generator. The bus arrangement is such that, in case of outage of one generator, the connections can be quickly

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In seven mills, new tonnage records were set with Mackintosh-Hemphill Technalloy Blooming Mill Rolls, thus reducing costs. In two of these mills, the new tonnage records established were double those of the best previous performance.

M-H Technalloy Rolls are made of enriched true alloy steel; they are especially heat treated to produce the required hardness of the body surface and are tempered so as to toughen them to resist spalling and crumbling under pressure. The journals are tough and strong and well able to withstand the imposed stresses.

Save money and establish new tonnage records. Specify M-H Technalloy Rolls.

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QUICK AND SIMPLE INSTALLATION
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A LARGE percentage of soaking pit cranes, within the past few years, have been equipped with Lintern Aire-Rectifiers. Our wide experience has lead to the development of a new model offering two distinct advantages: (1) a large saving in the space needed for location, (2) quicker installation.

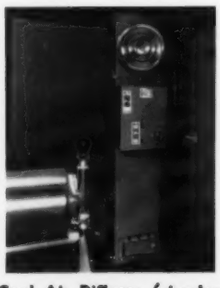
This new model takes about one-third less space than the former unit. Its weight is also proportionately less. It is being widely installed on existing cranes.

The Lintern Aire-Rectifier is composed of three units: Filter Chamber, Condenser-Blower Unit and Cab Unit. Ample filter capacity is provided in the Filter Chamber, yet it takes only 34 x 32-inch floor area on the footwalk — adjacent to the combination Condenser-Blower Unit.

Filter Chamber and combination Condenser-Blower.

The largest size combination Condenser-Blower Unit requires only 36 inches of width and 49 inches in length. The unit's proximity to the Filter Chamber may vary to suit the requirements of installation.

The cab unit, too, is small requiring a maximum of 12 x 12-inch floor area. In some very small cab installations the unit has been located outside the cab, with the Air Diffuser and Heater air inlet connected through the cab wall. This flexibility of installation reduces the time required for installation since there is little, if any, moving of existing equipment.



Cool Air Diffuser (circular disk) and Heater, at floor level, in crane cab.

Installation takes only a few hours and can be done during your periodic shutdowns for maintenance and repair.

We have a standard model Lintern Aire-Rectifier to fit any of your requirements. In order that your hot metal crane operators may be prepared to maintain production during the coming hot summer temperatures added to the present excessive fumes, gases and dirt, investigate now the merits of this air rectifying equipment.

THE LINTERN CORPORATION

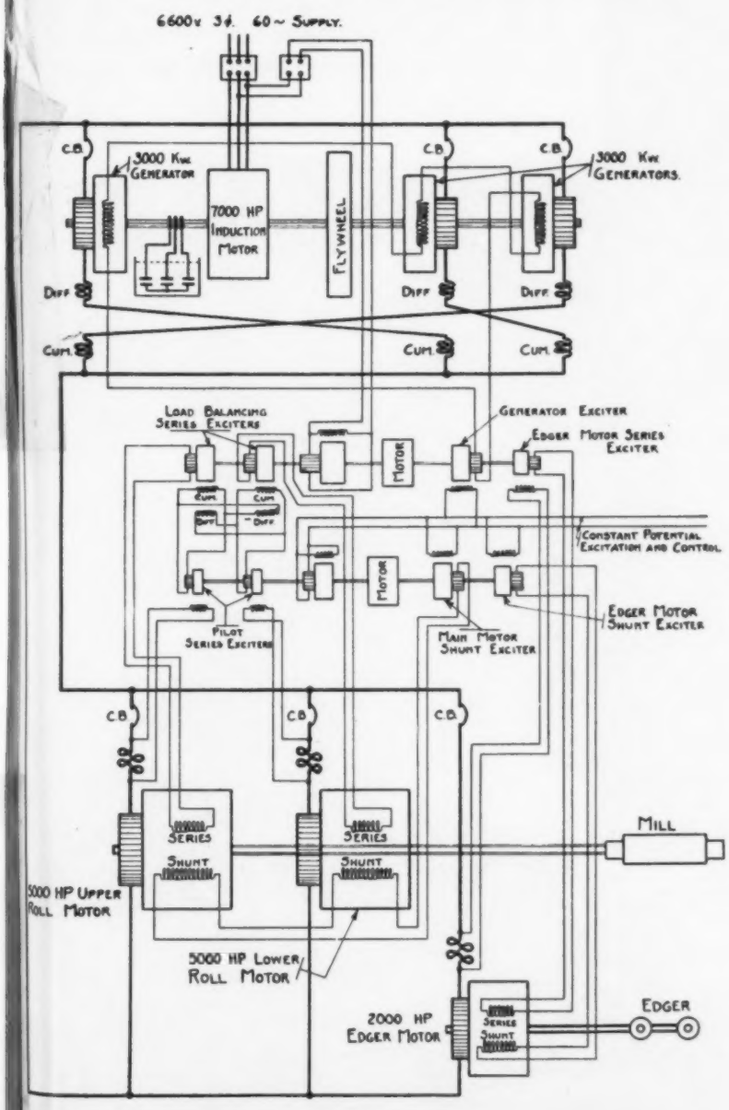
54 Lincoln Avenue ★ Berea, Ohio

changed to obtain proper cross-connections on the remaining generators. Two generators are sufficient for the majority of rolling schedules.

Four exciters are used to furnish excitation for the various machines. The shunt fields of the generator have their own exciter, as does the shunt field of the reversing motor. Control of these fields is accomplished by varying the fields of the exciters. A variable potential exciter is also provided for indirect compounding effect on the main motor, and a master exciter for constant voltage supply to control devices and exciter fields.

Another excitation system, used with a drive motor of the straight shunt type, uses one exciter to supply the fields of the reversing motor and a second exciter to supply the fields of the main generators. A third exciter generates a constant voltage and supplies excitation to the other exciters. The strength of the reversing motor fields is controlled by varying the voltage of the exciter supplying them. Field weakening is obtained by inserting resistance in the field circuit of this exciter. The voltage of the exciter supplying the generator fields is substantially constant. It is automatically regulated, however, so as to increase somewhat when the motor-generator set slows down, thus maintaining constant generator voltage.

Figure 64 — Diagram showing schematic connections for twin-motor drive with vertical roll drive.



In addition to the foregoing items, a reversing blooming mill drive includes switching, metering and protective devices, largely devoted to the primary a-c circuits; relays, contactors and resistors for the control of the field circuits of the reversing motor and main generators; circuit breakers for the d-c circuit between the reversing motor and the main generators; and a master switch, meters, etc., located in the operating pulpit.

Twin-motor drive. — In a number of cases, 10,000 hp drives have been designed using two 5000 hp motors. In this design, the mill pinions are eliminated and each mill roll is driven by an individual motor, in an arrangement as shown in Figure 63.

In the most recent installations, each roll is separately driven by a 5000 hp, 700 volt, 40-80 rpm, single armature d-c reversing motor, constituting a 10,000 hp twin motor drive of 10,000 hp, 1,300,000 lb-ft. full-load torque, and 3,600,000 maximum peak torque. The motors are designed with small diameter, long core armatures, so that the center-to-center distance between motor shafts is 94 in. The total armature inertia of the two motors is 3,200,000 lb-ft.[2]

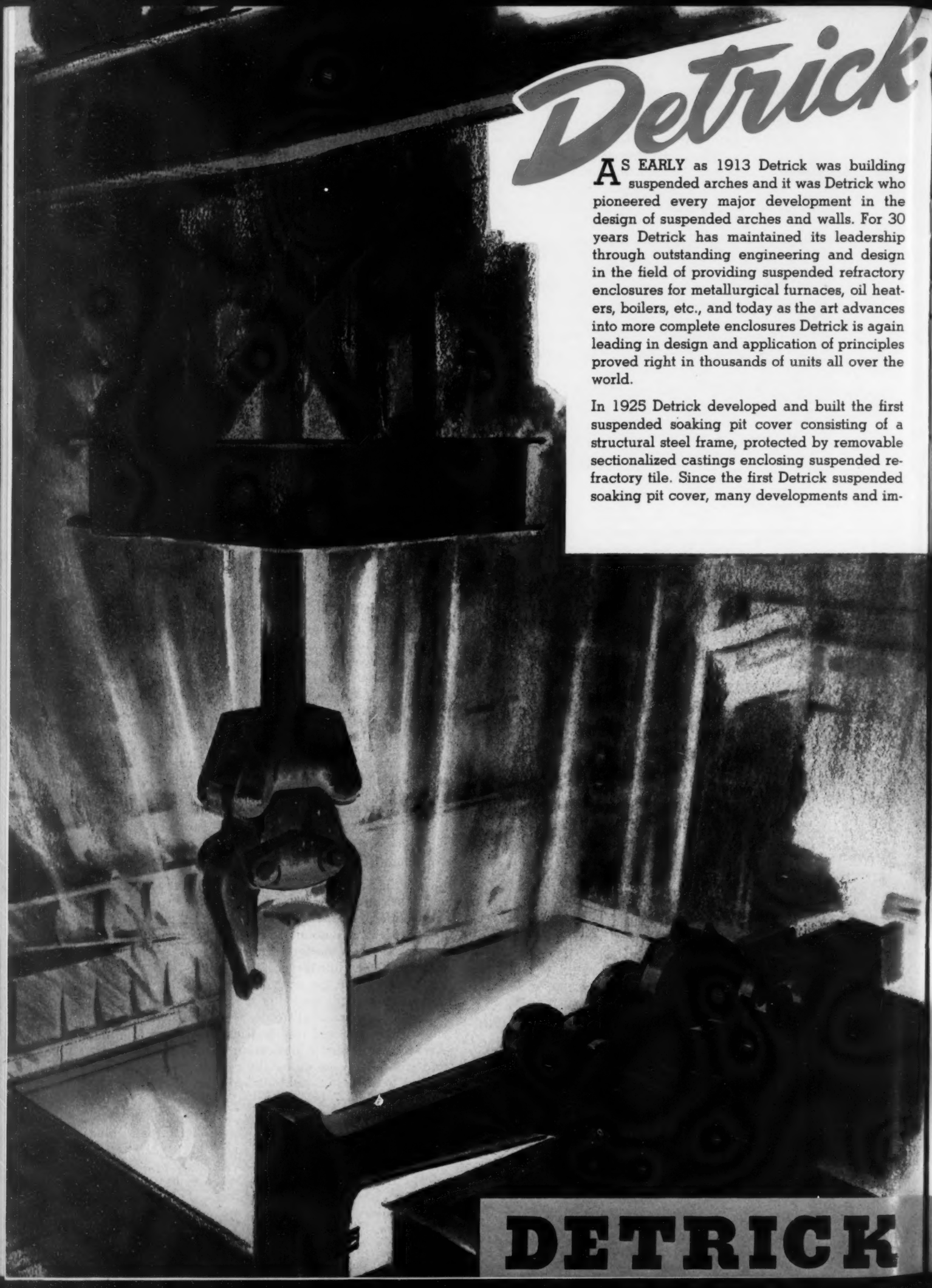
Electrical inter-connections between the two motors are laid out to balance the loads rather than to rigidly match the speeds, using two pilot series exciters and two load balancing series exciters, connected as shown in Figure 64. This diagram also includes an edger motor drive which is not synchronized exactly with the horizontal rolls.

Ventilation of the rotating electrical equipment is now generally accomplished by down-draft, with closed recirculating systems containing surface type air coolers, returning the cooled air into the motor room. Make-up air is usually drawn into the system through filters.

LUBRICATION

As is the case throughout the steel industry, blooming mill lubrication now depends largely upon centralized lubrication systems. Roll neck bearings, hand packed in the older installations, are served by grease pressure systems in the modern units, with a considerable increase in bearing life. Table bearings and gears no longer depend on the swab and oil-can. Enclosed bath and automatic lubrication of pinion teeth and bearings have almost eliminated trouble from that source. With the entirely enclosed mill housing, boots over the mill screws and automatic lubrication, the life of mill screws and nuts have been materially extended, with services of one to three million tons reported. Typifying the modern trend are the following lubricating facilities used on one of the latest mills:

One circulating oil system with dual pumps, cooler, filter and alarm system, 150 gpm, 6000 gal storage,



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AS EARLY as 1913 Detrick was building suspended arches and it was Detrick who pioneered every major development in the design of suspended arches and walls. For 30 years Detrick has maintained its leadership through outstanding engineering and design in the field of providing suspended refractory enclosures for metallurgical furnaces, oil heaters, boilers, etc., and today as the art advances into more complete enclosures Detrick is again leading in design and application of principles proved right in thousands of units all over the world.

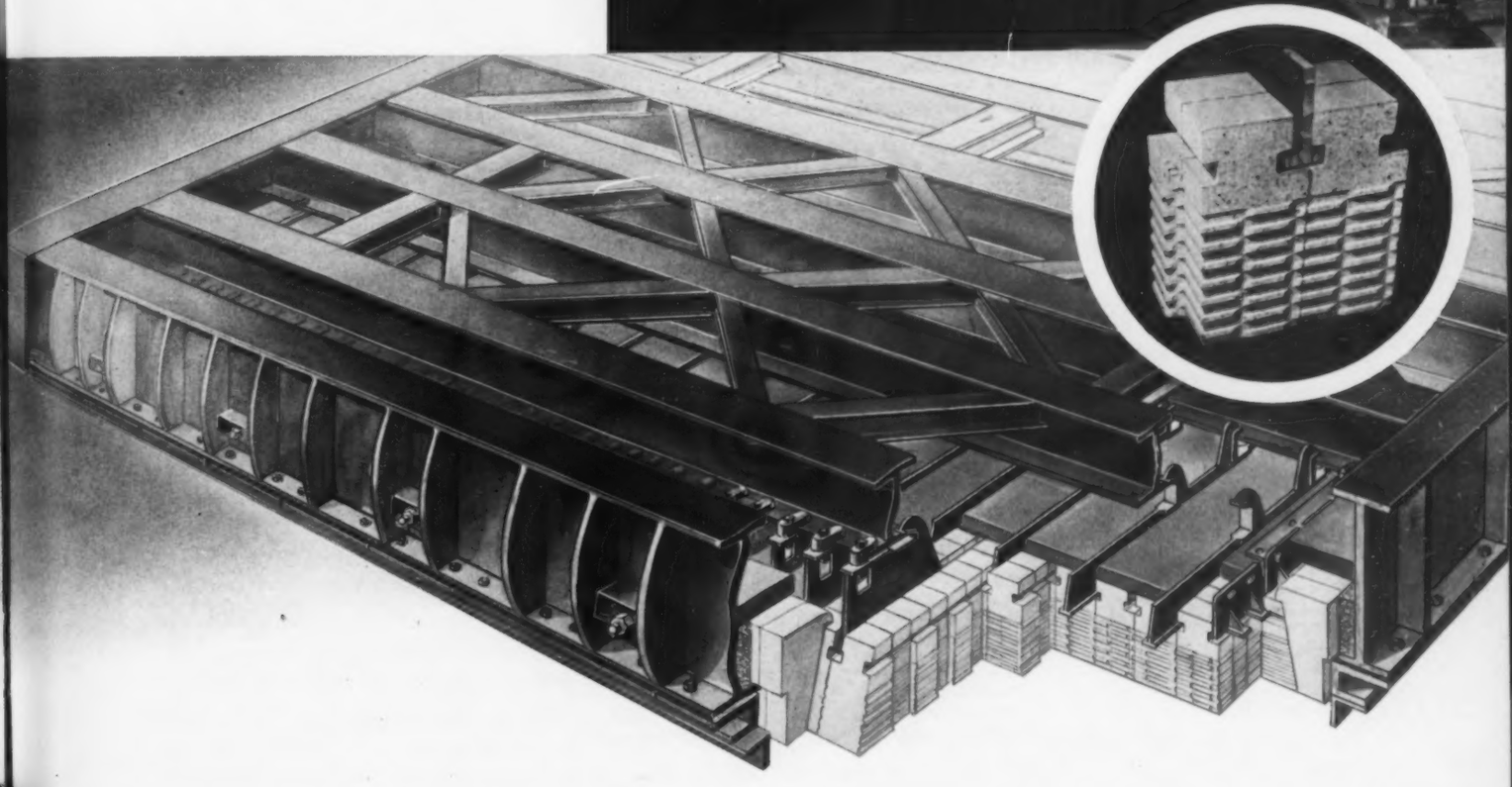
In 1925 Detrick developed and built the first suspended soaking pit cover consisting of a structural steel frame, protected by removable sectionalized castings enclosing suspended refractory tile. Since the first Detrick suspended soaking pit cover, many developments and im-

DETRICK

SOAKING PIT COVERS

provements have been made, dictated by experience and actual contact with hundreds of soaking pit covers under various operating conditions. This has resulted in the modern Detrick Soaking Pit Cover with numerous features all designed for the prime purpose of an efficient and tight cover, a rugged structure and a low maintenance unit.

Among the advantages of Detrick Soaking Pit Covers is the Detred Tile with its intermeshed construction which provides an airtight seal and prevents spalling. The wedge tile used on the sides makes it possible to repair the refractory portion of the cover quickly and economically. Extra support is provided all around the sides of the cover to strengthen it where service is most severe. It is characteristic of Detrick covers that they have inbuilt ruggedness to stand the gaff.



Detrick Soaking Pit Covers are used on all types and makes of soaking pits including those built by Swindell Dressler Corporation, Amsler Morton Company, Rust Furnace Company and Surface Combustion Company.

Detrick Engineers are ready to cooperate with you on any soaking pit job or other steel furnace wall or arch. Send for the new 1943 Catalog explaining Detrick construction principles.

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FURNACE ENCLOSURES

serving the drives and lineshaft of receiving, approach, and front and back mill tables.

One similar system, 220 gpm, 8000 gal storage, for manipulator and feed roll drive gearing, and for the mill screwdown.

One similar system for shear drive.

One motor-operated pressure grease system with automatic time clock control, serving mill bearings, chock slides, pressure blocks and roll balance bearings.

Two similar grease systems on bearings and sliding points of mill runout tables.

Four motor-operated pressure grease systems with push button control, one for bearings and sliding points of receiving table, one for approach table, one for manipulator bearings and sliding points, and one for the front and back mill tables.

Fifteen manually operated grease systems to lubricate bearings and other points on all other tables, pushers, shear, shear gauge, crop conveyor, transfer and slab pilers. All standard drives are splash lubricated. Table drives and lineshaft gearing run in oil unless otherwise specified. Other points not covered by the preceding equipment, which require infrequent lubrication, are provided with fittings for hand grease guns. A 50 gpm, 3800 gal storage circulating oil system may serve the main motor and motor-generator set. The pinion stand, both teeth and bearings, may be served by a 25 gpm, 850 gal circulating oil system.

Lubricant applications for blooming mill use as set up by one authority is given in Table VIII.

TABLE VIII — Lubricant Application

Roll necks, hand packed	Hard lime soap base grease. High tallow content. high viscosity and flash oil with 7 per cent synthetic graphite. Penetration point 56 unworked.
Roll necks, pressure system	Lime base grease, high viscosity and flash oil with 6 per cent synthetic graphite. Penetration point 220 unworked.
Mill screws and nuts	Steam refined cylinder oil, 180 sec viscosity @ 210 F, 21.5 Baumé, with automatic pumps.
Mill screws and nuts, high lift	Steam refined cylinder oil, 200 sec viscosity @ 210 F, 24.5 Baumé, 6 per cent acidless tallow, with automatic pump.
Mill pinions:	
With bath	Soda base transmission grease. With low viscosity, medium flash and fire. Test oil with 6 per cent synthetic graphite. 215 to 250 penetration point, or 5,000 sec viscosity asphalt pitch @ 100 F. Cut back to 3,000 sec viscosity @ 100 F, with 150 sec viscosity steam refined cylinder oil at 210 F.
Small, high and medium speed	Same stock as above cut back with oil to a less viscous body according to size and speed of pinions.
With oiling system, slow speed	2800 sec viscosity oil @ 100 F, 25.7 Baumé. Pour + 35 F.
Medium speed	2400 sec viscosity oil @ 100 F, 1800 sec viscosity oil @ 100 F, or 1250 sec viscosity oil @ 100 F, viscosity decreasing with size of mill.
Mill reduction gears with bath	Soda base transmission grease, 320 penetration point with 7 per cent synthetic graphite, high viscosity oil.
With oiling system	1750 sec viscosity oil @ 100 F for severe high speed work. For less work down to as low as 900 sec viscosity @ 100 F. Viscosity according to speed and work.
Worm gears:	
Normal work	Cylinder oil 143 sec viscosity @ 210 F, 24.8 Baumé compounded with 6 per cent acidless tallow.
Heavy work	185 sec viscosity @ 210 F, 24.4 Baumé. compounded with 6 per cent acidless tallow. Also 2700 sec viscosity @ 100 F. Extreme pressure lead base grease.
High speed, light work, warm condition	975 sec viscosity oil @ 100 F, 28.4 Baumé, compounded with oxidized paraffin compound.
Mill tables:	
Plain bearings, normal conditions	90 sec viscosity oil @ 210 F, 20.4 Baumé.
Hot condition, slab and heavy structure	180 sec viscosity oil @ 210 F, 21.4 Baumé.
Ring oiled high speed	320 sec viscosity oil @ 100 F, 23 Baumé.
Exposed tables outside mill plain bearings, summer	90 sec viscosity oil @ 210 F, 20.4 Baumé.
Exposed tables, plain bearings, winter	325 sec viscosity oil @ 100 F, 25.6 Baumé, — 6 F pour.
Mill tables, plain and roller bearings, hot condition	Lime soap base grease, with high flash and high viscosity oil. Penetration point 250 unworked.
Plain and roller bearings, cold condition	Lime soap base grease, medium viscosity and flash oil with + 8 F pour. Penetration point 285 to 375 according to speed.
Mill table gears, hot condition, swabbed	5,000 sec viscosity @ 100 F, asphalt pitch. For different temperature and rpm increase or lower viscosity.
Gears in bath	2,000 sec viscosity @ 100 F, asphalt pitch. Also, soda base transmission grease, with 7 per cent synthetic graphite. Penetration point 360 unworked.
Gear bath on single rolls, exposed winter	Soda base transmission grease. 290 penetration point. Cut back with 250 sec viscosity oil @ 100 F, 23 Baumé, — 8 F pour test.
Motors and motor-generator sets, continuous oiling system	160 sec viscosity @ 100 F, 26 Baumé. Pour + 16 F.
Motors, ring oiled:	
Normal temperature	160 sec viscosity @ 100 F, 26 Baumé. Pour + 16 F.
Temperature 125-150 F	300 sec viscosity @ 100 F, 24.8 Baumé. Pour + 20 F.
Temperature zero	140 sec viscosity @ 100 F, 24.5 Baumé. Pour — 12 F.
Motors, roller bearings	Grease, 385 penetration point worked. With 220 sec viscosity oil @ 100 F. Pour test + 6 F. Lime soap or soda soap base. With temperatures of 130-160 F, 320 penetration point worked, 350 sec viscosity oil @ 100 F, pour test + 20 F, soda soap base.
Motor-generator sets, high speed	160 sec viscosity @ 100 F, 29.4 Baumé. Pour + 24 F. High grade turbine oil.

CONDITIONING

A discussion of blooming mills would not be complete without some consideration of the conditioning of the blooms and slabs produced on the mill. This conditioning is necessary to remove checks, cracks, scabs, etc. from the surface, which might otherwise carry through subsequent heating and rolling operations. It might be well to emphasize that the heating and rolling of the ingot in the blooming mill has a profound influence on the bloom surface and consequently on the amount of conditioning required. Several methods are used to properly condition the bloom and slab surface: hand chipping, mechanical chipping, manual scarfing with oxyacetylene flame, and machine scarfing.

The oldest conditioning process is that of manual chipping, using pneumatic hammers and chisels. In general, there are two types of chisels used: One for deep cuts or gouges, with a narrow face and correspondingly small radius on the cutting tip; the other type of chisel, more generally used, is wide with a large radius on the cutting tip for relatively wide and shallow cuts. From actual service performance, it has been found economical to use alloy steel chisels which have been double treated, that is, quenched and drawn, to about 55 Shore or C-43 Rockwell in order to develop the proper strength and toughness for the shank and then, for a short length, requench and temper to obtain the required cutting hardness at the tip. The first treatment can be omitted, of course, when heat treated chisel blanks are purchased.

The cutting angle of the chisel is very important and has been given much consideration. It is reported that some plants may vary the cutting angle depending on the grade of steel chipped. It is more general practice to standardize on an "all purpose" angle. One plant found that the best results are secured for chipping a large number of grades of steel by having an included angle of 44 degrees between the cutting face and the radius on the bottom of the chisel tip. In this instance the angle between the cutting face and the center line of the chisel is 25 degrees (Figure 65).

The number of ground chisels used per man depends on the grade of steel being chipped and the scale condition of the steel. At a plant handling alloy steels as their main product which includes the hardest grades chipped, the average requirement for ground chisels is between 20 and 25 per man per 8 hr. shift.

In carrying out the chipping operations, it is not only necessary to remove the surface defects but equally as important to flare out the chipping marks so that in further hot reduction the chipping grooves will not be the cause of seams or laps. To do this, requires that the chipped grooves be at least twice as wide as deep.

Many specifications designate the limits of chipping permitted on semi-finished products. As an example, the wording of the A. S. T. M. specifications A-17-29, covering blooms, billets and slabs for forgings is quoted. "Billets may be chipped to remove surface defects, provided that the depth of chipping does not exceed $\frac{1}{16}$ in. for each inch of dimensions concerned, up to a maximum depth of $\frac{3}{4}$ in., and provided that the width of the chipping is at least four times its greatest depth; except that in cases of slabs where the width is at least twice the thickness, the depth of the chipping on the wide surfaces may exceed this allowance by 50 per cent, up to a maximum depth of $\frac{3}{4}$ in. In special cases, particularly with large alloy steel billets, where it is necessary and it is not injurious, greater depth of chipping may be permitted by special agreement between the manufacturer and the purchaser."

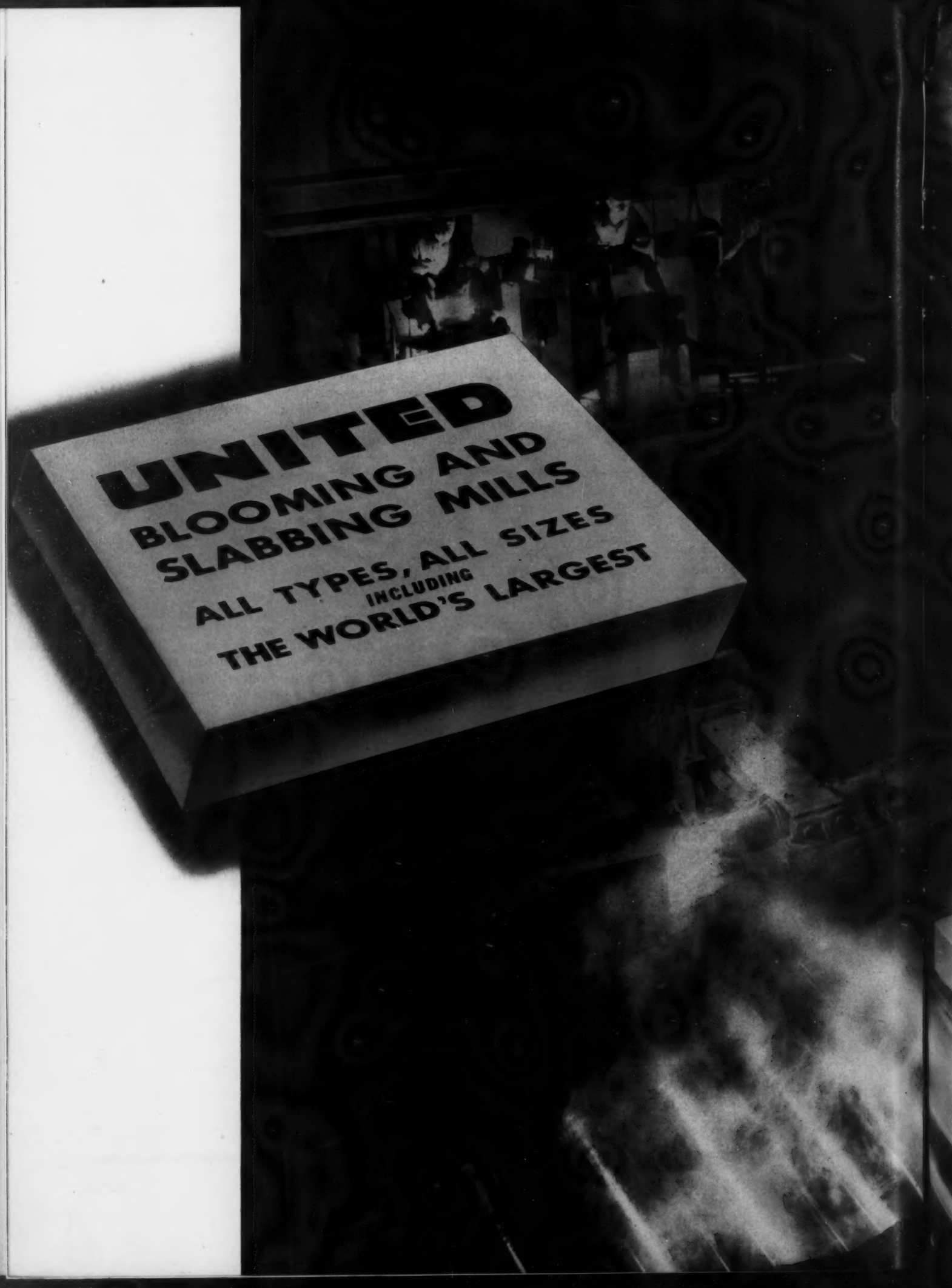
Chipping time varies widely from plant to plant, and specific figures are of little value. As a guide, however, the following figures from three different plants are offered:

A	Principally alloy	.3
B	Alloy and carbon	.7
C	Principally carbon	1.2

The chipping process has been mechanized by the development of the mechanical chipping machine, a specialized design of milling machine principle using a tool head holding six or eight cutting tools and operating at about 8 rpm. The tool head is carried in a movable carriage operating at 17 fpm forward and 34 fpm in reverse. The carriage is also movable from side to side and the tool head can be raised and lowered. All of these movements are controlled from a single joy-stick control. The machine is installed with tables and handling equipment. Operating results of mechanical chipping show tonnages ten times as great as with manual chipping.

More recently, oxyacetylene cutting has been adopted, at first manually and later, mechanically. Development of deseaming techniques for various size sections and grades of steel, along with better torches

Figure 65 — Chisels of this design were found to give good results in one plant chipping a variety of steels.


UNITED
BLOOMING AND
SLABBING MILLS
ALL TYPES, ALL SIZES
INCLUDING
THE WORLD'S LARGEST

UNITED ENGINEERING *and* FOUNDRY COMPANY

Pittsburgh, Pennsylvania, U.S.A.

and tips plus auxiliary starting equipment (by which steel is preheated for the start, very nearly instantaneously), has advanced to the point where today deseaming is being done on practically all grades of steel which burn under an oxygen stream and in all sizes down as small as 1½ in. x 1½ in. billets, both on plain carbon and alloy steels. The foregoing holds good for practically all grades formerly cleaned by chipping and a great number of grades formerly "swing ground." This includes practically every S.A.E. grade of steel with the exception of the corrosion and heat resisting steels. Also many special grades not listed on the S.A.E. lineup can be very readily cleaned by the scarfing operation.

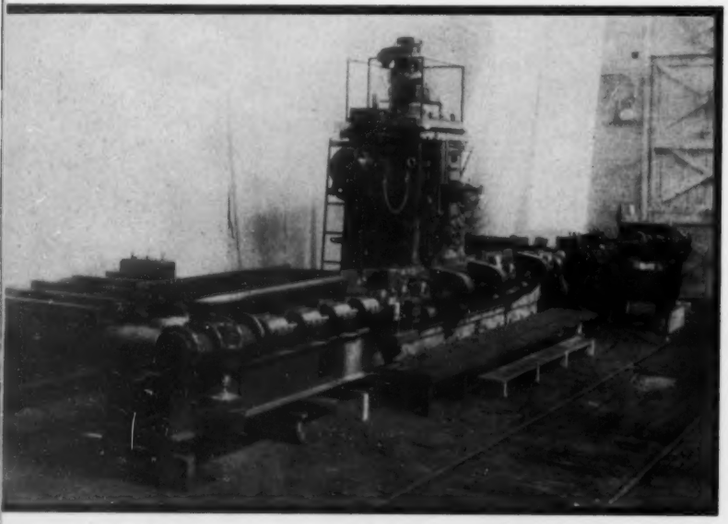
The first step in the operation after the equipment is set up and ready for use, is the preheating or "kindling" of the steel. Preheating is raising the temperature of the steel high enough and maintaining it so that the oxygen stream can combine with the heated surface of the metal and thus the cut or scarf is started.

Fast shallow cuts with the torch inclined to the right of the path of travel produce cuts without the high intervening ridges and thus keep the slag moving away from the surface already scarfed. A series of parallel cuts thus can be made, leaving a bright, clean surface, free of fin and which can easily be inspected for any remaining defects.

From hand scarfing, it was but a step to mechanical scarfing, wherein one or more surfaces of the steel stock is skinned by passing it through the flames of multiple torchs. At first, such machines were installed in the conditioning department. More recently there is a trend towards the location of the mechanical scarfing unit in the mill line, thus eliminating additional operations and gaining the advantages of hot scarfing, although at some sacrifice in yield on account of the complete skinning of the stock.

One plant producing only slabs uses a hot scarfing machine in an intermediate table between the slabbing mill table and the slab furnace charging table. Spaced

Figure 66 — This mechanical billet chipping machine is capable of taking a cut up to ¼ in. thick x 1½ in. wide.



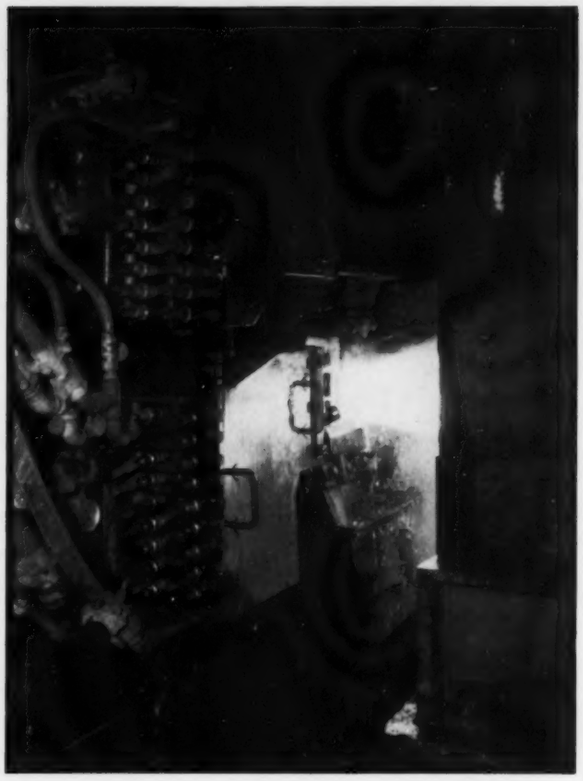


Figure 67 — Hot mechanical scarfing units are being installed in a great many blooming and slabbing mill lines.

across the width of the machine, below the slab, is a row of 64 nozzles on 1$\frac{3}{16}$ in. centers, grouped into 8 water-cooled heads of 8 nozzles each. The tops of these heads are hard-surfaced for maximum wear resistance. The nozzles are 1 in. in diameter, and carry a central slit, ½ in. x ⅛ in., for oxygen, surrounded by eight No. 59 drill holes for acetylene. Each nozzle is of a capacity to deliver 1850 cu ft of oxygen per hr. with oxygen-fuel ratio of about 6:1 while preheating and 20:1 while burning. Individual valves for each nozzle permit correct adjustment of the flow of the gases. The nozzles are slanted so as to fire against the direction of travel of the slab, their axis making an angle of about 25 degrees with the slab surface. Oxygen at 30 psi and acetylene at 14 psi are supplied from central systems, which distribute the gases throughout the plant.

The leading end of the slab is positioned above the scarfing head, and the acetylene ignites from the heat of the slab. After preheating for about 10 sec., the oxygen supply is increased, and the slab moved over the scarfing head. The speed of the slab through the machine is manually controlled by the operator through a rheostat on the table drive. The operating switch starts both the table and the scarfing flame. Slab speed controls the depth of the cut, regular material being scarfed at a speed of 150-160 fpm, with a layer of about $\frac{1}{32}$ in. thickness being removed from the bottom of the slab. Some grades of steel require a speed of 125-135 fpm, with a resulting depth of cut of $\frac{3}{64}$ in.

The bloom of the entire slab is thus desurfaced as it passes through the machine, and upon emerging, the slab is turned over on the table by a turning mechanism, returned back through the machine, and again passed through the machine, desurfacing the other side of the slab. Thus, a total thickness of $\frac{1}{16}$ in. is normally removed, which, with usual slab thicknesses, gives a scarfiing loss of 1.1-1.5 per cent.

The slag, melted and blown from the slab, is granulated by water, and drops through a chute into a buggy, which may be removed by overhead crane. Fumes are gathered by a hood and vented through an exhaust fan.

The scarfing head floats up against the bottom of the slab, thus following its exact contour and assuring proper scarfing action. The head is mounted on wheels and rails, allowing easy removal for adjustment and maintenance.

Gas consumption averages about 85 cu ft of oxygen and 6.5 cu ft of acetylene per ton of material scarfed. The maximum width which can be scarfed in this particular machine is 76 in. When processing narrower slabs, burners are turned off so that only the slab width is covered.

Another recent installation, which simultaneously desurfaces four sides of a bloom, is located in the blooming mill line. The machine will operate on blooms from 3 in. to 10 in. square, and removes about $\frac{1}{32}$ in. from each face at a material speed of about 170 fpm. By passing the material through at higher or lower speeds, thinner or thicker layers may be removed. Oxygen and acetylene are supplied to the machine from central generating plants.

This machine employs adjustable, multiple-nozzle blowpipes mounted on counter-balanced carrier plates. Nozzle protecting shoes are held with a light contact against the four sides of the bloom to insure precision of surface removal, and a special full floating action of the machine compensates for any ordinary vertical or horizontal camber of the bloom.

The nozzles of the four units, designed to operate in unison to leave essentially flat, ridgeless surfaces, are mounted in distribution headers. These four units are adjustable to provide for complete coverage of any section rolled by the bloomer, and the nozzles are adequately cooled by a closed water circulating system.

The machine is mounted on a motor-driven carriage which also carries the control valve panels and an idler roll to support the bloom during desurfacing. The machine carriage is installed transversely to the roll table on rails and may be run in or out of the line in a few seconds. All electrical controls and gas control valves are mounted on a table in the operator's pulpit, located in an elevated position at one side of the table. A smoke removal system collects and discharges all smoke and volatile products from the process, and the resultant slag is moved to a collection pit by a chute and high pressure water jets. This desurfacing machine is used successfully for the conditioning of various alloy grades of steel.

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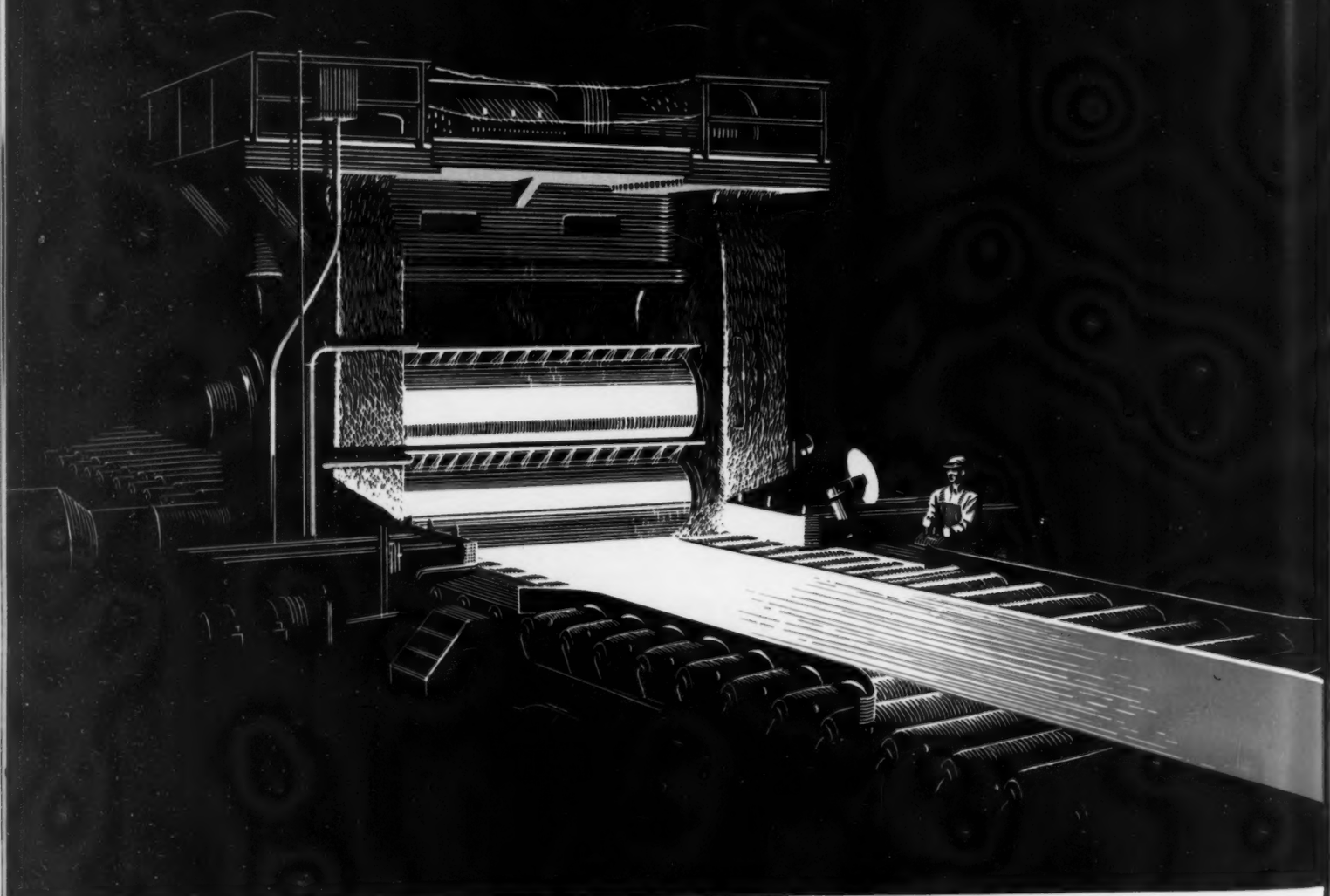
Drive problem solved



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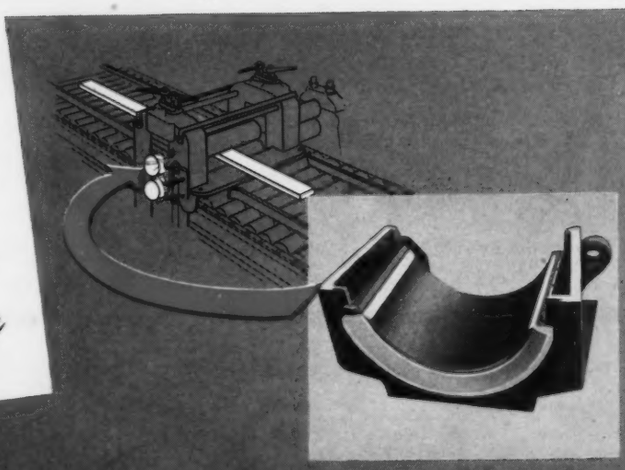

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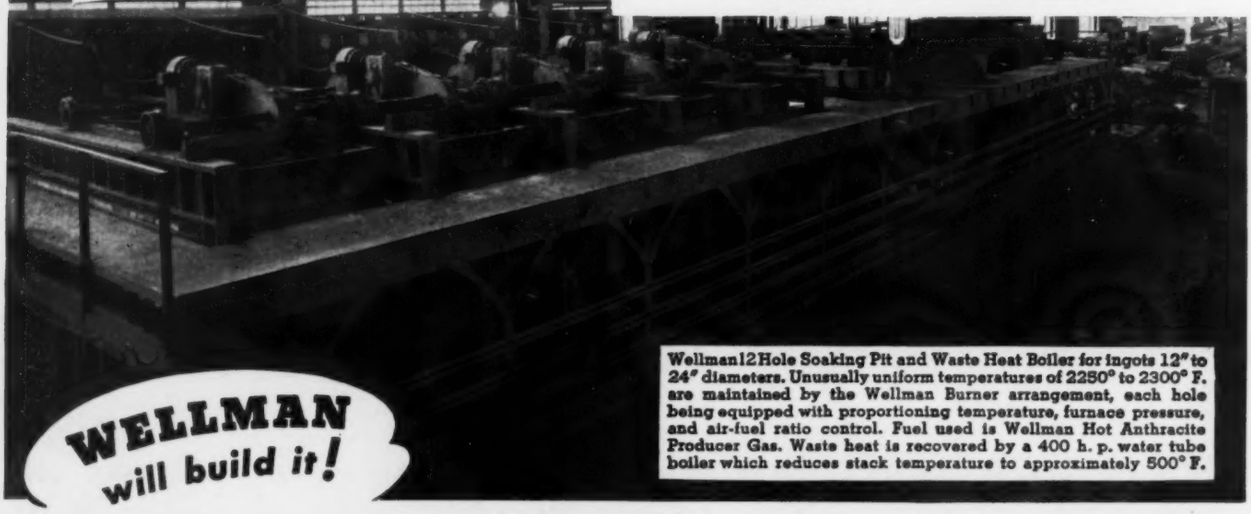

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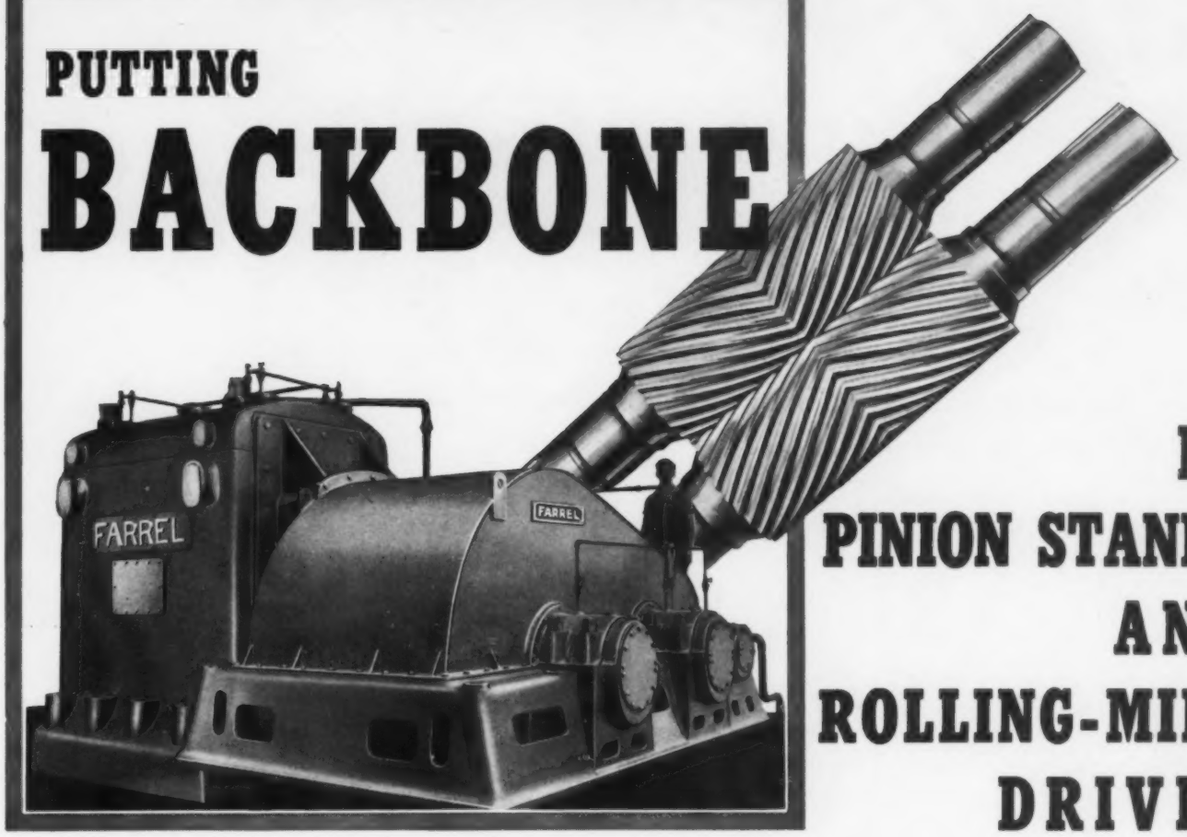
PUTTING BACKBONE IN PINION STANDS AND ROLLING-MILL DRIVES



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Conference Speaker

H. G. BATCHELLER

Hiland Garfield Batcheller, chief of the Iron and Steel Branch, War Production Board, will speak at the dinner to be held Monday, May 10th, in connection with the A. I. S. E. Spring Meeting sponsored by the Rolling Mill Committee. Born in Brooklyn, New York, Mr. Batcheller was educated at Glens Falls Academy and Wesleyan University. Going with Carnegie Steel Company in 1909, he worked in the sales department until 1915, when he became associated with Ludlum Steel Company, advancing successively to vice president, executive vice president and president of that company. In 1938 Mr. Batcheller became president of the new Allegheny Ludlum Steel Company, moving to his present Washington post in 1942. Mr. Batcheller's experience and present position enable him to bring a message of particular interest to engineers and operators in the steel industry.

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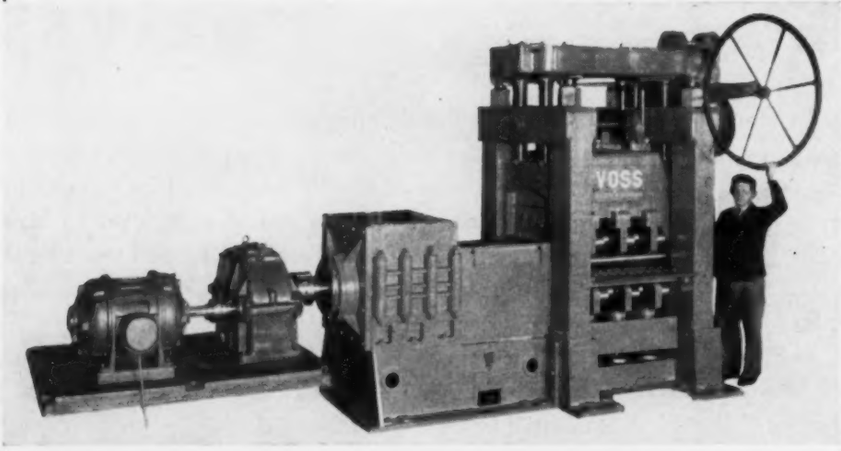

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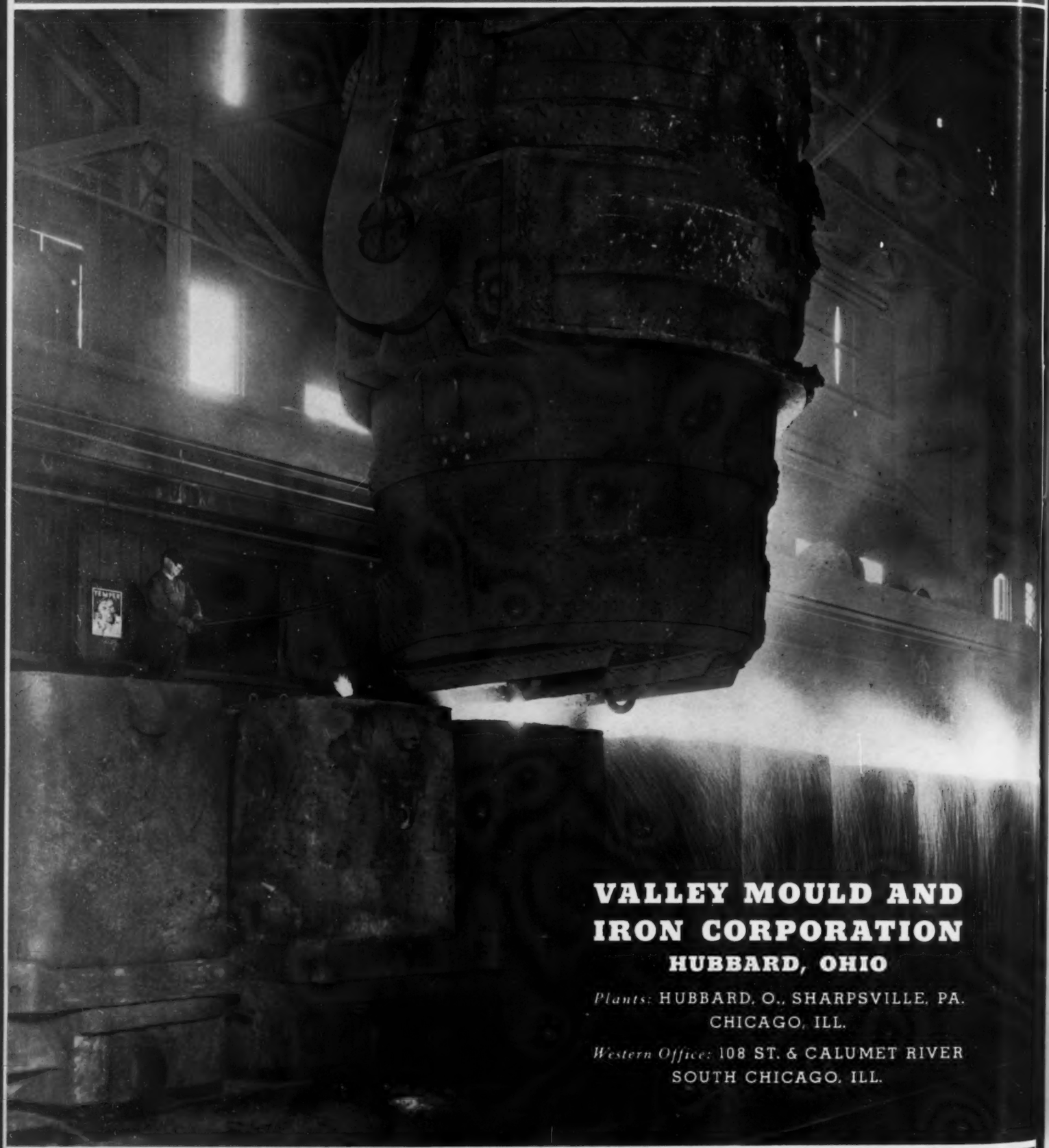

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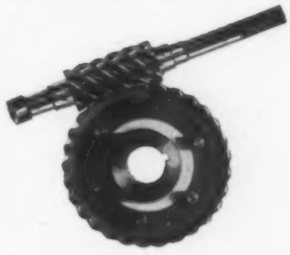

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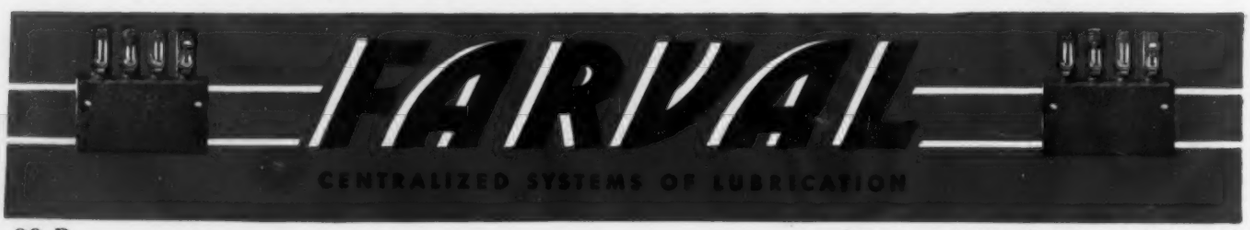

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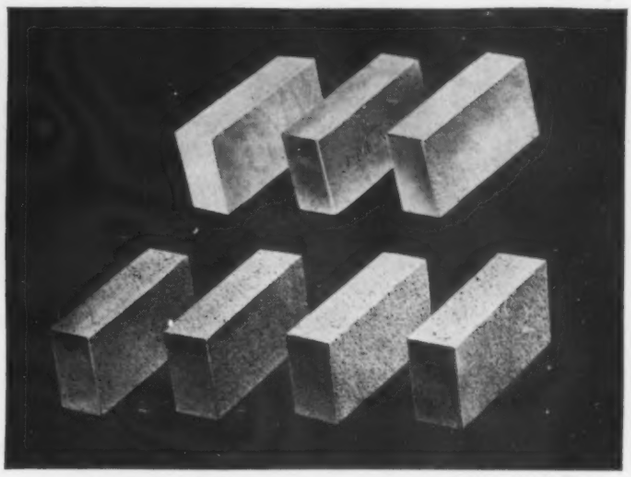

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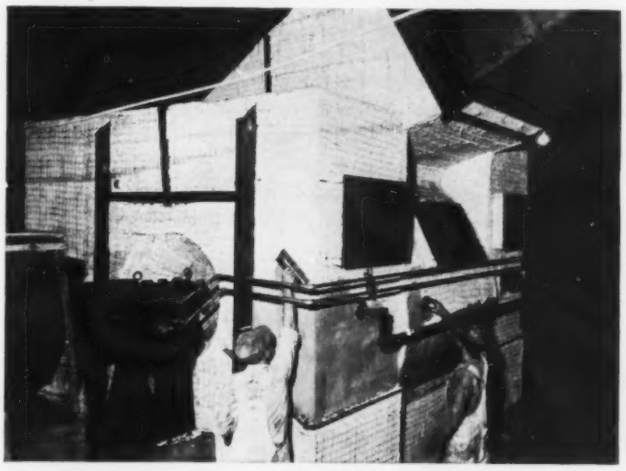

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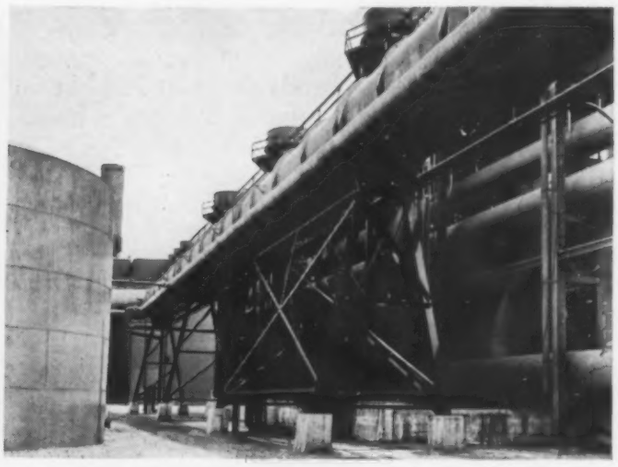

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Practical Turbine Lubrication

. . . . this survey of turbine lubrication brings out a number of advantages afforded by modern lubricants . . . .

by S. R. O'Dette

Standard Oil Company of New Jersey

New York, New York

▲ IN A discussion of the subject of turbine lubrication many factors are involved. Some of these factors, because of today's operations, are particularly important. The need for continuous operation of all power generating equipment in our war effort emphasizes more than ever the importance of lubrication and the ability of a lubricant to improve continuity of operation. The effectiveness and nature of the lubricant in a turbine may affect not only such continuity of operation but, to an important degree, the operating cost.

Several of the factors influenced or controlled entirely by the lubricant in a steam turbine can be listed as follows:

1. Machine downtime and labor for cleaning lubricating systems.
2. Lubricating oil cleaning (filtering, centrifuging, etc.).
3. Make-up or sweetening.
4. Machine parts failure and replacements.
5. Fuel costs.
6. Cost of lubricant.

The following discussion will dwell on the general subjects of turbine lubrication systems and lubricant functions, requirements and maintenance.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 22-24, 1942

Figure 1 — Placement of piping, coolers and controls in the oil reservoir. Rust and oil decomposition products cannot be tolerated in such systems.

TURBINE LUBRICATION SYSTEMS

Piping and general layout — There are many large differences in design between large and small and between new and old turbines. Steam pressures are relatively low in the older units and the construction of these turbines usually is such that lubrication systems can be readily dismantled for cleaning. Such simplicity of construction is often employed on small modern units

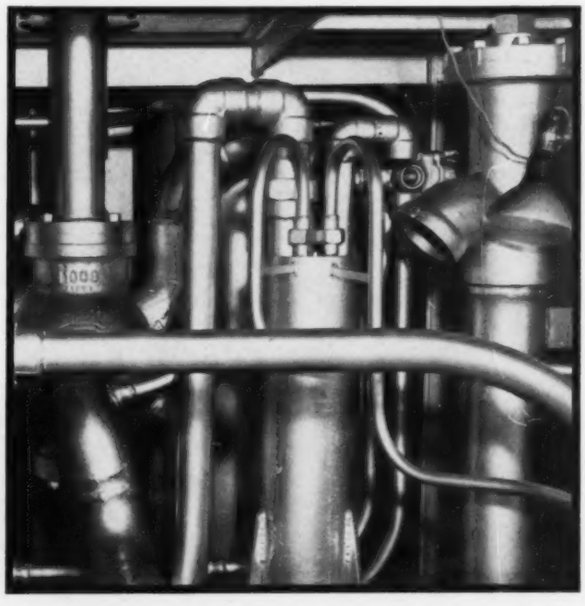


Figure 2 — Showing ribs in upper part of oil reservoir, drilled to permit effective ventilation of vapor phase area above oil level which is clearly shown by the "foam line."

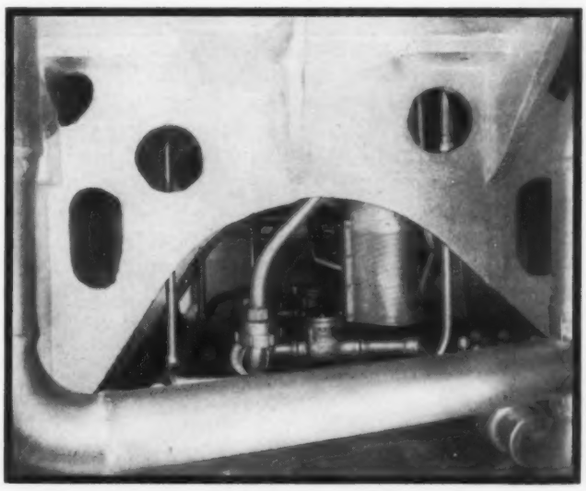
but not on the larger high pressure, high temperature turbines. In the larger machines, ranging from 5000 kw upward to 100,000 kw per unit, a large amount of the piping is assembled by welding, and small oil passages are cast in the turbine structure itself. One large manufacturer, for example, carries the pressure oil piping within the return oil piping, all being fabricated in place by welding.

Further complications arose with the advent of high pressure - high temperature steam. A serious hazard was that of fires caused by oil line breakage or leaks which sprayed the lubricating oil on the hot exposed parts of the turbine. Disastrous oil fires did occur and, in the attempts to eliminate this danger, early consideration was given to the possibility of non-inflammable lubricants. The hazard was finally reduced greatly, however, by removing or shielding high pressure oil lines from hot steam lines and valves. The unavoidable result was greater complication in the lubricating system.

Many machines installed today take steam at high pressures and temperatures and exhaust at lower pressures, to older or lower pressure turbines. They also bleed off steam at various temperatures to operate other equipment or to supply other needs within the plant. All of these functions are controlled by automatic apparatus which use the oil from the lubrication system as a hydraulic medium. Not only is this a further complication to the lubricant system, but the extremely fine clearances in such control mechanisms place new requirements of stability on the lubricant. These requirements of stability and cleanliness are further heightened by the present practice of placing much of the oil piping and control mechanisms within the oil reservoir.

Any necessity, therefore, to dismantle such modern systems for cleaning due to oil failure or degradation is not only prohibitive from a machine-down time and cost standpoint, but there is little possibility of removing all deposits from parts and oil passages. Sludge or solid deposits which are left in the system promote degradation of the new oil, interfere with the oil flow or are carried to other parts of the system where they can and do result in parts failure, shutting down the unit.

Figure 3 — Modern turbine using cast reservoir as part of turbine, showing vent ports cast in reinforcing structure.



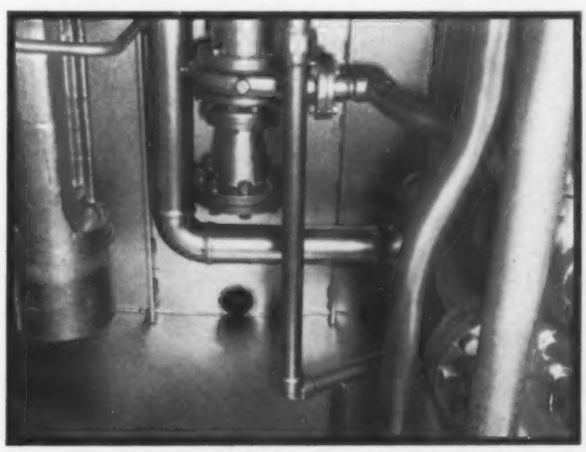


Figure 4 — Modern construction showing sloping bottom of welded steel construction with drain and line to centrifuge in immediate bottom.

Reservoirs — In the older turbines the oil reservoir is usually cast iron and is an integral part of the turbine construction. It either supports one of the bearings and governing mechanism or is a part of the turbine casing itself. Some machines utilize the base or foundation of the turbine as a part of the lubricating oil reservoirs. Reinforcing ribs in the base may be so placed that they

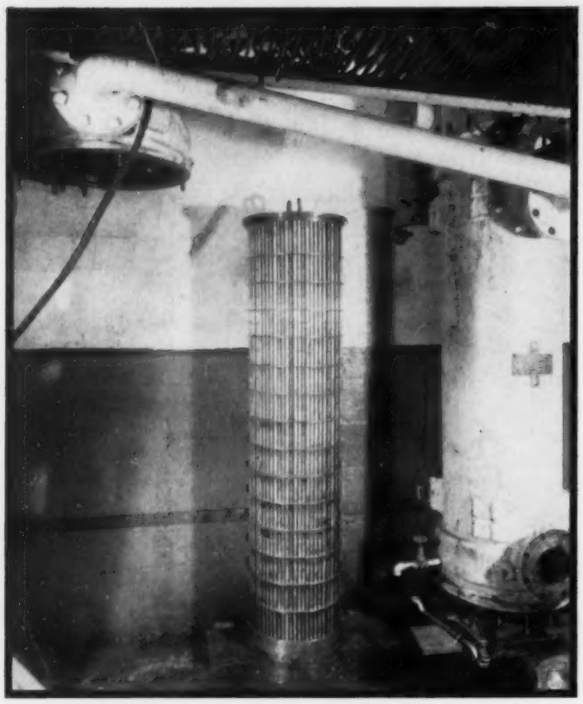
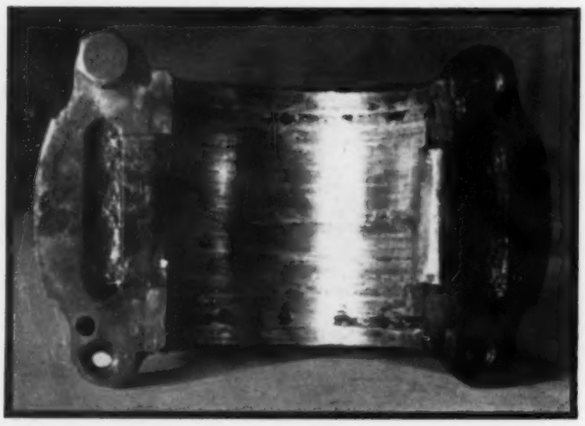
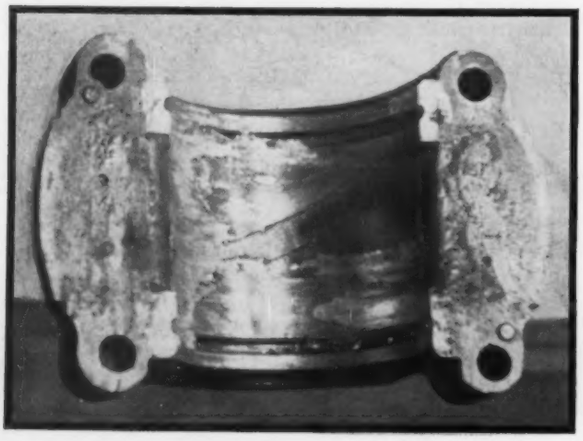


Figure 5 — Oil side of cooler after 22,500 service hours. No deposits or lacquer, permitting efficient heat transfer to condensate used for cooling.



Figures 6 and 7 — Bearing failure resulting from oil decomposition products lodging in clearance area.



act as a trap for water and deposits or prevent proper venting. Reservoirs of this type cannot always be cleaned completely and thus may cause contamination of the fresh oil. Because of this situation many of these machines have been and still are considered difficult to lubricate.

In the newer machines the use of cast iron in the construction of oil reservoirs is confined almost entirely to small auxiliary units. Reservoirs for the larger turbines are fabricated from steel plates and placed in such position that they are more accessible for inspection. Because of the importance of cleanliness of the lubricant, the trend is to construct these reservoirs with sloping bottoms. A portion of the oil can then be brought practically to rest and drain openings can be connected so that precipitated water and solids can be readily removed, either by draining or by using oil cleaning and filtering apparatus. Many of the flat bottomed oil reservoirs have their drain-off connection several inches above the bottom of the tank. These reservoirs have been improved materially by adding a water leg to the bottom of the sump as a means of effectively collecting the water and solids. Where it is impractical to use the water leg construction, a bell-bottomed suction pipe from the purifying system can be placed directly on the bottom of the sump, preferably immediately below but removed from the vertical main oil pump suction. This method of draw-off permits removing the concentration of moisture and solids in the quiescent vortex center between the main oil pump suction and the floor of the reservoir. Such installations improve the efficiency of oil maintenance procedure.

In some of the later designs the shallow, broad oil reservoir is giving way to the tall, narrow reservoir. One advantage is that the area of exposed metal above the oil level, subject to rusting, is reduced. A further advantage is that, due to the lower oil velocity near the bottom, tall tanks permit precipitation of water and solids more readily than do the shallow tanks where the oil flow is maintained at a more uniform velocity. Turbine oil service records indicate that the best reservoir construction is the tall type combined with the sloping bottom connected to the purifying system at the lowest point.

Oil cooler placement — Oil coolers are often placed in a horizontal position and in some part of the engine room where they cannot be dismantled readily for cleaning. Because of space limitation and structural designs, the coolers are often found below the lowest point of the lubricating system thus providing a place for deposits to collect. Since such formations are particularly undesirable in or on cooler tubes, the ideal situation is to place oil coolers in a vertical position at least on a level with the oil reservoir and certainly not below it. Cleaning of the oil side of lubricating oil coolers can be completely eliminated by careful selection of the lubricant and efficient operation of oil maintenance apparatus coupled with correct oil cooler placement. In fact, the possibility of maintaining clean oil coolers makes it possible to utilize these coolers as heat exchangers in the condensate line to recover valuable heat units which in normal operations are fed to the sewer.

Turning gear operation — When a high pressure turbine is being shut down it may require at least 24 hours

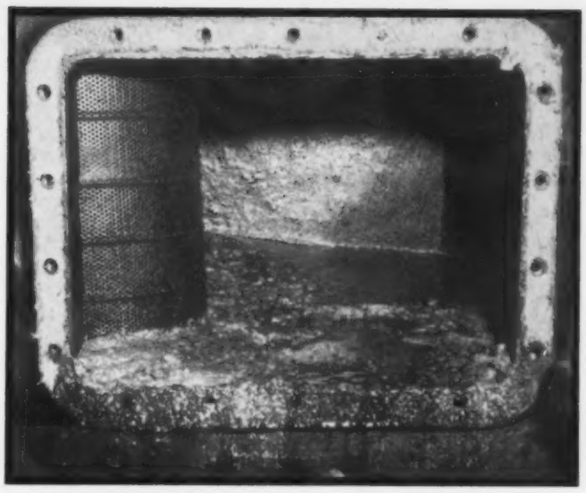


Figure 8 — Sludge accumulation in cast iron reservoir after 8000 service hours, using overfinished lubricant which was not responsive to inhibitors.

in turning gear to reduce the rotor and casing temperature to about 250 F where the machine can be stopped without fear of distortion. During this time, although the dynamic loads supported by the bearings are quite low, difficulties can be encountered in bearing lubrication due to the difficulty in maintaining oil films at low journal speeds. If the lubricating oil contains contaminants, these may lodge and solidify in the oil entering side of the bearing shell at the low oil viscosities existant. Several disastrous bearing failures have occurred from this cause — either during stopping or when bringing a machine up to speed during its starting period. Investigations have shown that these failures were due to a tar-like mass of deposit which formed between the bearing and the journal and prevented the possibility of establishing a fluid film.

The viscosity of the lubricating oil should be as high as possible while the machine is in turning gear. A number of turbine builders have recognized this and recommend that when a machine is to be taken off the line and placed on turning gear the oil coolers be opened wide in order to reduce the temperature and increase the viscosity of the oil as rapidly as possible.

TURBINE OIL FUNCTIONS

In a modern turbine installation the lubricant has more than a single function. Obviously, lubrication of the main supporting bearings is its primary job. In addition, however, the lubricant is required to dissipate much heat conducted to the bearings and it must operate many hydraulic devices. In performing such functions, modern operation has newly emphasized a function previously little recognized — that of protection of the many oil-bathed surfaces from corrosion and deposit formation.

Lubrication — Turbines have rarely been built with insufficient bearing area to support the loads. In fact, in some of the older machines the bearing areas were so large that it has been found advantageous to reduce their size in order to lower the operating temperatures of the bearings by reducing the amount of fluid friction. A reduction in the bearing area of as much as 40 per cent in such turbines has been accompanied by a decrease in oil temperatures of 20 F — in itself an advantage in prolonging oil life. In general, however, turbine bearings are almost the ideal case for fluid film lubrication. Loads may range from 20 to 200 psi with 50 to 150 the average. Speeds of the journal fall in the neighborhood of 150 to 175 fps and radial clearances average .002 in. per inch diameter.

Because of the high speeds in the turbine spindle (except during turning gear operation) there is an adequate pumping action of the journal itself which carries oil into the bearing area in sufficient quantities to float the spindle on the oil. The high rotational speeds and the large amount of heat conducted to the journal from the steam in the turbine itself make it imperative, however, that the oil film not fail as even slight interruptions in the fluid film may be sufficient to score surfaces or overheat the metal. This causes bearing surface distortion which, in some instances, has caused complete failure before the turbine could be stopped.

Viscosity requirements of the lubricant vary, depending upon the speed of the turbine, the method of lubrication, and whether or not reduction gearing is lubricated simultaneously. In other respects, however,

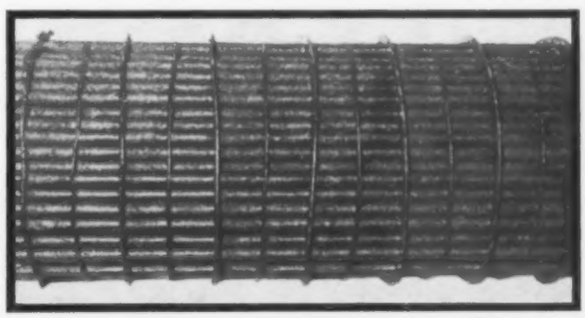
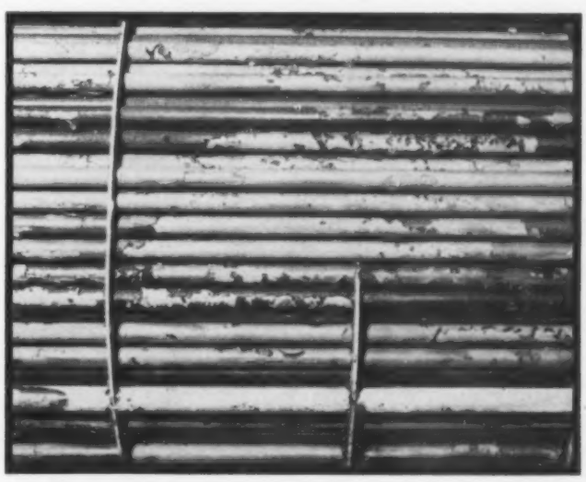


Figure 9 — Badly fouled oil cooler after 8000 service hours using unstable lubricant.

Figure 10 — Effects of highly acid turbine oil attacking cooler tubes, etching the metal and presenting a hazard by releasing large particles into the oil stream.



the strictly lubricational requirements of a turbine oil are relatively simple.

Cooling — The oil reaching a bearing must do more than simply provide a lubricating film. Many times the volume of oil must reach the bearing than is required for actual lubrication. The major portion of the oil circulated acts as a coolant; one investigator estimates the heat extracted by the bearing oil in a large turbine to be 2,000,000 Btu per hour. The temperature of the oil actually supporting or lubricating the bearing spindle is much higher than that observed in the oil return flow from a given bearing. Accurate observations indicate that the oil actually lubricating the turbine spindle may leave the pressure area at temperatures near 250 F. Since the relative volume of oil actually supporting the spindle is about 10 per cent of the total volume fed to the bearing, the total oil temperature leaving the bearing is always much below this figure. In respect to the function of cooling or heat transfer, it is obvious that deposit coatings on bearings, surfaces of lubricating systems, cooler tubes, etc., from the lubricant are most undesirable.

Hydraulic medium — Modern turbines incorporate exceedingly complex mechanisms to give the precise control and automatic operation now expected of all prime movers. Almost all such devices depend, at least in part, on hydraulic service and control units utilizing the turbine lubricant as the hydraulic medium. The critical nature and close tolerances of such devices impose new requirements of stability and cleanliness on the lubricant far exceeding those considered outstanding even a few years ago.

Surface protection — Since some water can always be anticipated within a lubricating system and since even minute quantities of water will promote corrosion of ferrous metal surfaces, it is necessary that the lubricant effectively "wet" all surfaces bathed by the oil, to prevent the water from coming in direct contact with the surfaces. This protection must be accomplished without impairing heat transfer. In fact, all bathed surfaces must be maintained physically clean. It goes without saying that the lubricant itself must not be injurious, as for example by acidity developed in use, to the turbine system.

QUALITY REQUIREMENTS

Considering the more critical nature and expanded number of turbine lubricating oil performance requirements, the matter of quality has become of increasing interest. Quality, with respect to stability, resistance to formation of deposits, surface wetting ability and ease of separation from water and extraneous material, is of importance to the turbine operator today, not in any abstract sense, but in the practical matter of lost time and maintenance cost resulting from any necessity for unscheduled changing of lubricant or required cleaning of the lubricating or hydraulic system. Principal quality considerations are acidity development, oxidation, resistance to water and, now a specialized case, corrosion prevention.

Acidity — All turbine oils are practically neutral when new. In use they develop a slight amount of acidity which, in the modern oxidation inhibited turbine oils, does not increase rapidly until near the end of the useful life of the particular batch of oil.

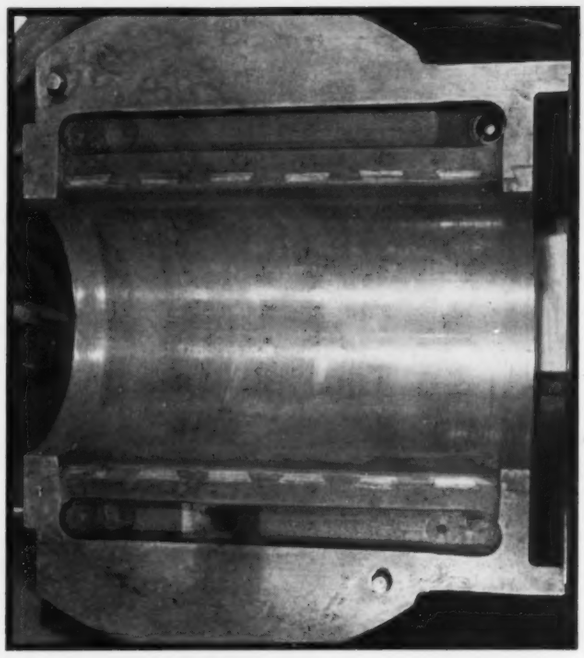


Figure 11 — Appearance of properly lubricated bearing. Note complete absence of deposits or lacquer after 22,500 service hours.

In normally refined turbine lubricants, particularly of the older type containing no added oxidation inhibitors, continued operation may raise acidity steadily and noticeably. This acidity is due to free acids resulting from a type of oil oxidation and, if excessive, may gradually attack the metal of the turbine system and form metallic soaps. This is especially true where much

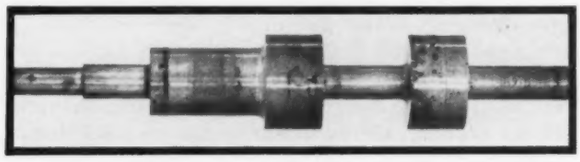


Figure 12 — Pilot valve of control throttle, showing etching on highly finished surfaces.

Figure 13 — Effects of corrosion on excess speed governor throw-out pin.

copper or zinc bearing metal alloys are in the lubricating system. Both these free acids and their metallic soaps are active in accelerating the formation of emulsions. The soaps, if highly concentrated, may also precipitate to add to the sludge deposits formed in the system. However, while the acid content of an oil may even discolor metal parts, real damage due to corrosive action from this source alone is doubtful unless high values of acidity are reached. Acidity is of principal interest as an index of the rate of oil deterioration due to oxidation.

Oxidation — Petroleum oils — just as all organic matter — will oxidize slowly to form other substances. Regardless of the degree of refining, the crude source, or the protective additives introduced, oxidation will slowly but surely take place. Oxidation can be retarded but cannot be completely stopped. Important to the turbine operators is the fact that the rate of oil deterioration can now, in most cases, be reduced to an almost negligible amount over long periods of time by selection of a modern, correctly finished turbine oil, intelligent design and operation of the turbine, and by adequate oil maintenance.

The actual process of oxidation may take several forms. The results are increases in viscosity, development of acidity, sludge formation, or other effects. Some oxidation products form deposits, either solid or lacquerlike, or may cause corrosion. Such oxidation products obviously are detrimental to turbine operation and their formation should be prevented. Other residues and oxidation products may be inert and have little or no bad effect. The type of crude stock and refining methods used in making a turbine oil greatly influence its oxidation characteristics.

Resistance to water — Moisture is the most common contaminant tending to prevent turbine oil from functioning continuously in its quadruple role as a lubricant coolant, surface protector and hydraulic medium. It is virtually impossible to exclude all moisture from the oil system. Water may enter through leaky glands, cooling coil leaks, broken or leaky gaskets, faulty water seals or by condensation of moisture from the atmosphere caused by the unequal temperatures prevailing on the inner and outer surfaces of oil reservoirs, gear cases and bearing housings. If, as is usually the case, the turbine cannot be shut down immediately to repair gland or cooling coil leaks, large amounts of water may enter the system. The water may leak from cooling tubes which are embedded in the bearing metal as an aid to cooling. The sweating which occurs in the pipe connections in the bearing housings provides a further source of moisture.

Although pure water alone is not injurious to clean oil, it must be removed promptly, since large quantities may float the lubricant above the oil pump suction. There are numerous operating difficulties, which may be traced to moisture in the system or which may be aggravated by the presence of such moisture.

Turbine oils must have the highest possible resistance to emulsification with water. Laboratory tests are run on new oils to show whether the oil separates quickly from mixtures formed with steam or water fed into the oil. However, once the oil has been placed in service, this initial ability to separate from water (called demulsibility) may be rapidly reduced because of contamination with oxidation products of the oil and with dirt or acidic material. Such laboratory tests are, at best, only an indication (at that, often a false one) and cannot be blindly relied upon to judge the service value of a turbine lubricant.

For practical purposes, turbine oil emulsions can be considered as a mixture of oil, water and solids, and air. These substances, although generally immiscible with one another, can be combined mechanically in such a manner that they are held in suspension. The resultant types of emulsions range from milk-like mixtures, commonly seen in machine tool grinders and cutters, to a tough liver-like material which may deposit on bearing areas, oil reservoirs, cooler tubes, etc. These latter formations are often totally insoluble in petroleum solvents and, although classed as emulsions, are really deposits of petroleum decomposition products.

While common emulsions in themselves are not always harmful, they do not make good turbine lubricants and, when pumped through the system, may cause real harm. In passing through the close clearances of the governing apparatus, or in the pressure area between the journal and its bearing, the pressures and temperatures tend to break the emulsion. This causes the solids present to precipitate and adhere to these areas, forming hard deposits. Under aggravated conditions, such as when a high temperature turbine is being started or stopped, the solids built up in the bearings by this action may totally disrupt fluid film lubrication. If full speed operation follows, a bearing failure may result.

Figure 14 — Under side of cast iron sump cover operating wet and with badly decomposed oil. Surface is covered with rust barnacles and deposits.

Surface protection — The lubricant obviously must not be injurious, under any condition reached in service, to the materials of the lubrication system. Difficulties of such nature are rare today. A special case, however, is the requirement that the lubricant protects surfaces against corrosion by moisture, which is almost

inevitably present. This requirement is now of such importance that it will be considered separately.

Protection against water corrosion — Excessive water or moisture within the oil system may cause serious corrosion, particularly in the areas in the system which are not bathed with oil. Because such areas are relatively cooler than the lubricant itself, moisture condenses on the surfaces. As the moisture drops into the lubricant, it carries with it finely divided particles of rust. These particles are of two types: (1) the finely divided oxides that are very catalytic to oil destruction; and (2) the magnetic oxides which, because of their tendency to collect into larger particles, are a great mechanical hazard when carried in the oil stream.

Moisture corrosion also can develop even on surfaces bathed with oil, due to inability of the oil to displace deposited moisture. Moisture corrosion may occur both with new systems and in systems where lubricant has been in use for a considerable time. Corrosion of non-oil bathed surfaces is largely independent of the oil. In either case the corrosion can be severe — it has even progressed to a point where it has totally destroyed governing mechanisms and has also resulted in bearing failure.

Particular emphasis is placed upon the moisture corrosion which can occur when starting new turbines. Moisture then carried in the oil will cause serious corrosion unless the lubricant has sufficient metal wetting ability to prevent the free moisture from coming in contact with the fresh metal surfaces of the lubrication system. Many of the corrosion difficulties with new turbines are due to the unfavorable conditions sometimes encountered in starting a new turbine — particularly when operating temperatures are held too low permitting large quantities of water to accumulate in the system.

Because of the apparent ability of used oil to form better rust preventive films on turbine surfaces, there have been recommendations that a certain percentage of used oil be added to new oil when installed in a new turbine. Gaining the necessary rust preventive protection by contaminating a high quality new oil in this manner is a poor compromise and one which should not be tolerated when a better alternative is available.

Modern chemistry has provided a much more practical solution. Wetting agents have now been developed which may be added to a new turbine oil as a finishing step in its manufacture. While some agents of this type may create other drawbacks, wetting agents have been found which do not materially affect the oil in any other respect. Oils are now available which will substantially eliminate, even in new systems, corrosion due to entrained moisture, and without sacrifice of oxidation stability or any other important quality requirement.

Many field observations make it clear that rusting of non-oil bathed parts of the lubrication system may at times be a serious problem. Therefore, methods must be at hand for minimizing or eliminating oil deterioration and the operating difficulties which result from corrosion from this source. Developments have established certain facts and procedures which provide these methods of protection.

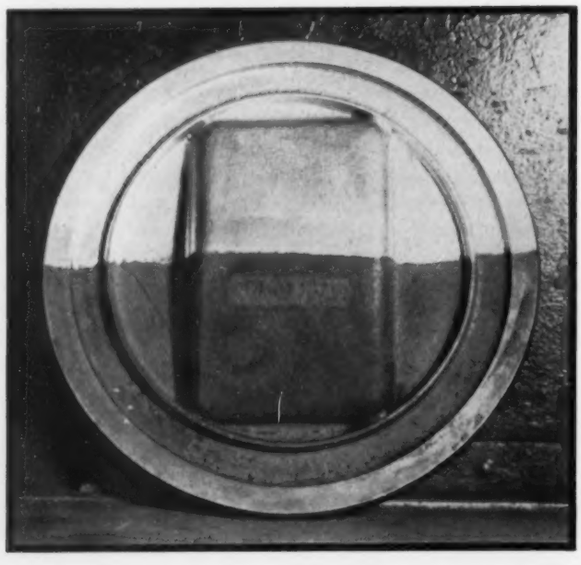
In turbines having cast iron sumps with broad roofs and large oil surface area, corrosion of exposed metal surfaces is quite common. Rusting is seriously aggravated when water cooled bearings and gland seals leak badly, or when the engine room temperature is so low as to cause condensation of moisture on the reservoir surfaces. It is impossible to protect these superposed areas by maintaining a film of lubricant. In turbine oil reservoirs formed by welding or riveting steel plates, corrosion occurs when the operating conditions are similar to those which accentuate corrosion with cast iron.

In many cases where the products of corrosion have been a problem, real improvement has been made by fitting or equipping many large turbines with bag filters, centrifuges, wash towers, or combinations of these, so as to remove such corrosion products promptly. Various procedures for turbine oil maintenance will be discussed in a separate section.

With the realization that some water will inevitably be encountered in any lubricating system during the life of a turbine, studies have been made in an effort to develop coatings that might be readily applied to the interior or the surfaces of a lubricating system, such as the internal parts of the oil reservoir, bearing and governor housings, gear and coupling cases and the air and hydrogen detraining apparatus where gas cooled generators are used. The coating applied must last a very long time, during which it must prevent rusting and remain unchanged itself, not peeling or flaking off to form particles which would be carried in the oil stream. It also must be impervious to both oil and water at elevated temperatures. Many available oil insoluble coatings are pigmented with materials which accelerate oil oxidation. Other coatings satisfactory in this respect are unsuited because of their poor bonding to metal surfaces or because of other objections such as very slow drying rates.

A long search involving extended laboratory and service tests among the oil impervious products pig-

Figure 15 — Sump cover thoroughly cleaned to bare metal. One-half coated with rust preventive, the other left bare to show the effect of water on clean metals not bathed by the lubricant.



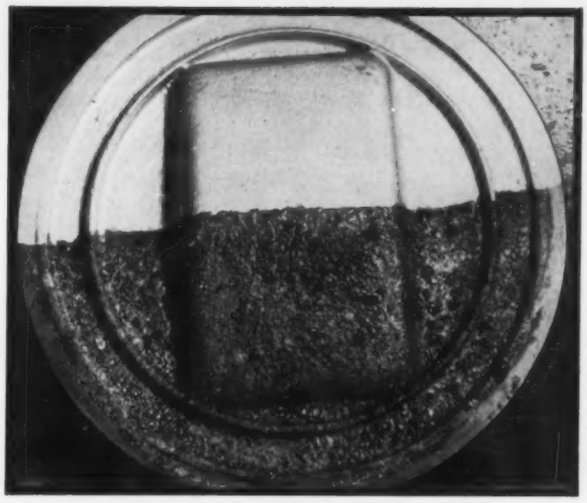


Figure 16 — Sump cover of Figure 15 after 15 days service. The unprotected surface is badly rusted and is reaching the "barnacle" stage.

mented with metallic tin, aluminum, lead or titanium, has shown that at least one coating, using a synthetic vehicle pigmented with finely divided pure aluminum meets all service requirements.

TURBINE OIL MAINTENANCE

Necessity for oil maintenance — Proper equipment for turbine oil maintenance is highly desirable in any turbine installation. Throughout the period the oil is in service it is exposed to contaminating and deteriorating influences which can shorten the life of the oil unless proper and adequate steps are taken toward oil maintenance. Water, for example, which enters the lubricating system through condensation or leakage must be removed. Also, oxidized oil materials, dirt, fly ash and other foreign matter, all of which are potential sources of trouble, must be removed promptly and effectively if full use of the turbine oil is to be realized. There is real economy in proper oil maintenance due to the protection afforded the lubricant during its life and due to minimizing the expense of regular cleaning of the lubricating system.

Oil maintenance may also prevent expensive machine shut-downs caused by mechanical failures. In many instances large machines have operated successfully for several months with defective glands which permitted large quantities of water to reach the lubricating system. In several cases the effectiveness of the cleaning devices was demonstrated in large turbines that encountered electric current leaks between the journal and bearings. This condition caused the original oil to decompose to such a degree that it was necessary to dispose of the entire charge of oil in a short time, yet in four definitely known cases where a high quality lubricant had been subjected to this electrical discharge and had become very black, it was readily restored to its original color and characteristics by the simple expedient of using a blotter press through which at least 2 per cent of the oil was by-passed over a period of several days. In each instance, the oil was returned to its original physical condition and there was no measurable indication of any injury having been suffered by the oil.

Although many steam turbine operators have more or less standardized their methods of turbine oil maintenance, there still exist wide differences of opinion on the effectiveness of this important equipment. A number of plants have discarded originally purchased filtering or cleaning equipment because of unsatisfactory results. Others are using cleaning equipment for their turbine oil, yet fail to realize the full efficiency which can be obtained when such equipment is properly operated in conjunction with turbines. One reason for this condition may be that many of the older and less stable turbine oils were actually oxidized by the continuous churning and aerating in the conventional centrifuge. Also, in the case of some oils, continuous centrifuging or filtering removed no solids until oxidation had reached a point where the solids precipitated so rapidly that they exceeded the capacity of the cleaning system.

Oil maintenance equipment — Equipment commonly used for oil maintenance includes centrifuges, bag filters, oil conditioners, blotter presses, asbestos filters, rest tanks and combinations of these. In the operation of any of this equipment there is a definite need for the turbine operator to filter the oil at higher oil temperatures than he might normally select. Previous experience with some lubricants, supplemented by the recommendations of some oil refiners and filtering equipment manufacturers, has established a common belief that oil temperatures higher than 130 F should not be used. Yet practical experience has shown that it is almost impossible to remove finely divided solids and moisture from turbine oils when filtered at these low temperatures. Today engineers are recommending periodic centrifuging at 150 F or even 180 F, with excellent results.

It will be found that centrifuges will separate finely divided solids and water much more efficiently if, in

Figure 17 — Bearing failure caused by rust particles lodging in entering side of bearing disrupting the oil film.

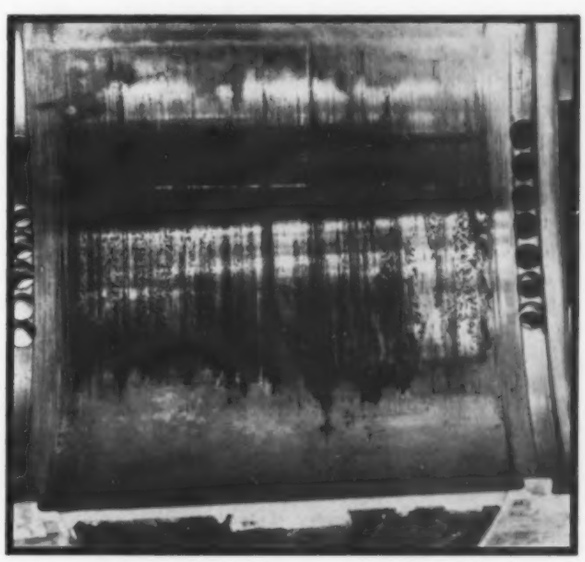


Figure 18 — Steel reservoir cover operating on wet machine. Rust formation resulted in frequent failures and oil changes.

addition to raising the oil temperature, the rate of oil passing through the unit is decreased considerably. Excellent results are obtained by operating at 50 per cent and even 25 per cent of the rated capacity of the centrifuge. Many of the impurities in the lubricant are maintained in suspension by the high rate of circulation in the lubrication system. Centrifuging should be at a slow enough rate to remove these materials.

It is often desirable to add hot water to the lubricant going to the centrifuge. One reason is that some of the products of oil oxidation are water soluble and are thereby dissolved and washed from the lubricant. Hot water performs another function on finely divided products, such as oxidation products, fly ash, atmospheric dust and metallic oxides. When wetted, these particles coagulate or coalesce, forming particles of such magnitude that they can be more readily extracted in the centrifuge. When centrifuging without water these products may not be removed at all despite their tendency to deposit in the lubricating system.

Centrifuge capacity is often too small. If planned only for normal needs, the unit may be incapable of meeting abnormal demands resulting from large water leaks into the oil system.

The conventional bag filter is capable of removing water and finely divided solids if the rate of the oil passing through the unit is sufficiently low so that high turbulence is not encountered. The failure of many filters of this type to maintain oil in the best possible condition can usually be traced to operating the filter at too low temperatures and at such large flow rates that the finest particles are literally forced through the cloth filter. These finely divided solids are far more destructive to the lubricant, in accelerating oxidation, than are the larger particles of solids and water which the filter normally removes.

Increasing the oil temperature to at least 150 F and at the same time materially reducing oil flow provides contact filtering which removes much of the entrained water and causes fine particles to impinge on and cling to the cloth filter. The addition of hot condensate with the lubricant in the precipitation compartment prior to passing through the bag filter is rapidly gaining favor for the same reason that it proves effective in centrifuging. Wetting the finely divided solids causes them to coagulate and form larger particles which are collected on the surfaces of the bag filter.

Blotter presses have proved quite satisfactory for the removal of small quantities of moisture and finely divided solids entrained in the oil. One difficulty in the use of such equipment, however, occurs when the oil supply for the blotter press is taken from a connection on a high pressure oil line. Inasmuch as the suction of the main oil pump is somewhat above the bottom of the oil reservoir, solids and water which have concentrated below the pump suction are never removed from the system.

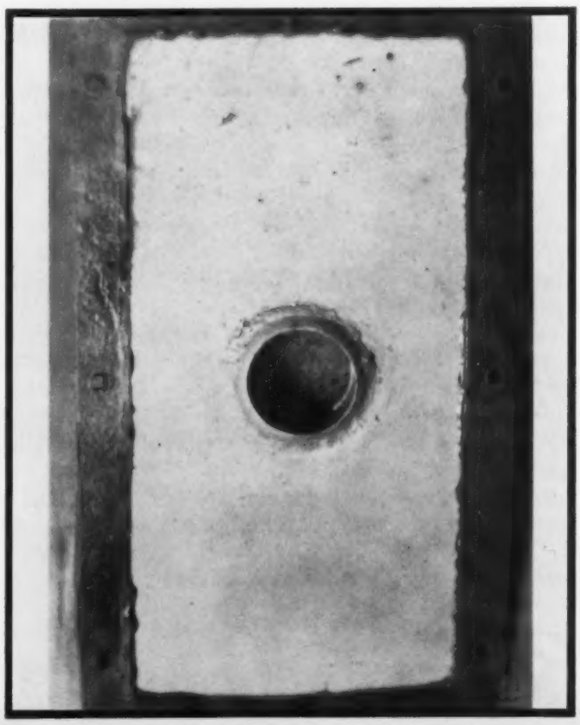
Another type of mechanical filter finding great favor among turbine operators is one fitted with asbestos wafers of varying density. Oil flow rates are extremely high considering the effective filtering area of these units. The reduction in solid particle size is readily accomplished by the selection of the correct wafer density. Wafers can be secured that will even remove certain bacteria from water. Filters of this type are very effective in removing finely divided suspended rust particles.

Filters using absorptive clays are not widely used as regular filtering apparatus on steam turbines, both because of the adverse effect of moisture on the filtering effectiveness of clay and the high cost of the filtering medium.

On all the types of oil maintenance apparatus which have been discussed above, it should be noted that the efficiency of the cleaning operation is greatly increased by drawing the oil from the intermediate bottom of the oil reservoir.

Settling or resting a batch of oil consists of removing the entire charge of oil from the lubrication system, storing it in a tall tank and permitting it to rest for an extended period. The intention of this treatment is to precipitate water and products of oxidation which are normally soluble in the oil at operating temperatures but which tend to separate out at room temperatures. The difference in specific gravity of the impurities and the oil is so slight, however, that it is usually difficult to obtain a sharp separation.

Figure 19 — Protected surface after three years continuous service.



Settling has no effect on removing deposits from within the lubrication system itself, with the exception of those on the bottom of the oil reservoir. The practice of settling is not generally considered economical for several reasons. It is expensive to maintain several batches of oil, particularly since oil losses under this method are quite high. The usual practice is to draw off only the clean oil from the upper portion of the settling tank, while the sludge and precipitated solids are dumped to waste.

Further reason for disfavor of this method of oil maintenance is the fact that if emulsions are present, the water does not separate readily. In general, it has been found to be more efficient and economical to utilize a by-pass filtering system so that part of the oil is cleaned either continuously or periodically. Thus, removing the oil from the lubrication system is necessary only during the time of mechanical inspection.

One method of turbine oil maintenance still used by some operators is known as "sweetening." Under this method approximately 10 per cent of the oil in the system is drawn from the bottom of the oil reservoir periodically and is placed in settling tanks, where the water and solids are allowed to precipitate. Fresh make-up oil is added to the turbine system.

The used oil from the settling tank is not returned to the turbine, but is used for the lubrication of auxiliary machinery of minor importance throughout the plant. With this method there is always the possibility that the large amount of new oil added to the turbine may precipitate solids from the oil in use.

This practice is costly not only because it increases the oil volume required for make-up, but mainly because it is not effective enough to prevent frequent expenditures for cleaning the turbine system.

Turbine oils which have the greatest ability to resist oxidation do not require sweetening or excessive make-up oil to maintain them in good condition. The only make-up required is that occasioned by system leaks and losses in filtering and centrifuging. If the oils are properly handled, such losses are small.

CONCLUSION

Machine downtime for cleaning lubricating systems — It should never be necessary to dismantle a lubricating system for cleaning if correct lubricants are used and normal maintenance measures are pursued.

Lubricating oil cleaning — This is not a complicated function and should not increase labor cost in plant operation if properly maintained. Proper operation and functioning of lubricating oil cleaning systems is necessary since oils maintained in clean condition will naturally maintain the lubricating systems in the same manner.

Make-up or sweetening — The cost of oil make-up in properly maintained systems is based entirely on the tightness of the system and the care exercised in operating filtering equipment. Since, with proper lubricants and maintenance, it is not necessary to resort to sweetening, oil make-up costs should be negligible.

Parts failure and replacements — With the total exclusion of rust formation within the lubricating system, the prevention of sludge formation deposits, etc., parts failures attributable to the lubricant are negligible.

Fuel cost — Since the newer type lubricants operate successfully at higher operating temperatures and since these lubricants, properly maintained, assure continually clean coolers, effective heat transfer is maintained at peak efficiency. The recommended procedure is to return oil to the turbine at temperatures not lower than 110 F, returning from the bearings at temperatures from 130 F to a peak of 170 F. Temperature rise through a bearing is not alone a function of entering oil temperature rise. Entering oil temperature should be raised to where the lowest temperature rise through a bearing is experienced. Observations have been made where a power saving of as much as 74 kw has been accomplished by the simple expedient of correct adjustment of oil temperatures.

Many plant operators taking advantage of the uniformly high heat transfer coefficients when maintaining clean coolers are now using condensates from the main condensers as the cooling media, thereby regaining valuable heat units for the boiler feed water.

Cost of the lubricant — Since the operating service obtained on the modern lubricants in correctly designed and maintained systems extends up to 50,000 service hours or more, and make-up is negligible, it is apparent that the cost of the lubricant is readily written off by the savings in labor cost otherwise expended on system cleaning, parts replacement and unnecessary power consumption.

DISCUSSION

PRESENTED BY

JOHN F. PELLY, Lubrication Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

STANLEY R. O'DETTE, Engineering Division, Standard Oil Company of New Jersey, New York, New York

W. H. MANDY, Lubrication Engineer, The Texas Company, Pittsburgh, Pennsylvania

GEORGE H. KAUFFELD, JR., Special Representative, The De Laval Separator Company, Pittsburgh, Pennsylvania

CHARLES R. HAND, Lubricating Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

J. F. PELLY: I heard the phrase "newer type turbine oil." How long has that term been used in connection with turbine oil and what does it mean? What has been done to turbine oil to justify that new term? Were the old oils unsatisfactory?

S. R. O'DETTE: The term "newer type turbine oils," I admit, is rather loose. By that designation we mean the solvent extracted or highly refined materials which practically all of the major refiners are adopting to a great degree.

J. F. PELLY: I don't think that quite answers the question. Why did you make the change?

S. R. O'DETTE: Seeking improvements.

J. R. PELLY: Did you get them?

S. R. O'DETTE: Yes, we got them, definitely.

J. R. PELLY: What is the improvement? We had turbines in our plants for many years, and I never heard any discussion about rust in them. I can cite cases where the oil stayed in them for as long as twelve years without a filtering system, so I am interested in having some explanation of the justification for a change to a new oil which requires all this care.

S. R. O'DETTE: In your older machines I believe you were cleaning coolers at least annually, were you not?

J. R. PELLY: I would say so, yes.

S. R. O'DETTE: Oil make-up under those conditions is quite high, will run possibly twelve to twenty barrels a year per machine, if it is above ten or fifteen thousand kw capacity. That is a pretty close figure, is it not?

J. R. PELLY: Yes.

S. R. O'DETTE: And when you consider all of the cost factors even in the older machines, your new type lubricants, oxidation inhibited, are much more economical for various reasons. A clean system obviates the necessity of ever taking a machine apart for cleaning. Oil losses are negligible. You can operate at higher temperatures than you could with the older distillate type lubricants, and the consequent saving in power cost alone is often enough to permit you to buy a new batch of oil every month. The oils that you purchased twelve years ago may not be obtainable now. Experience shows that the older type oils are not too successful in the modern machine.

W. H. MANDY: I would like to ask, have you found any separating of the inhibitor with this newer type turbine oil in the clay type filter? Do you experience any loss of the inhibitor when the oil is run through the asbestos type filter?

S. R. O'DETTE: With any mechanical filter you do not affect the additives, and the asbestos type, of course, is just a mechanical filter, being a condensed or closely woven asbestos wafer, or commercial gooch filter. With adsorptive clays, however, certain additives can be removed and are removed.

W. H. MANDY: One other question. You mentioned fly ash. I wish you would explain what you meant by that.

S. R. O'DETTE: Products of combustion found in all power houses, whether you are burning coal, wood or oil. Usually that found in lubrication systems is as fine as atmospheric dust. Since the gears and couplings act as fans they literally pump air into the system and bring in these finely divided particles.

G. H. KAUFFELD, JR.: I would like to ask Mr. O'Dette whether any oxidation inhibitors used in the so-called new turbine oils are water soluble.

S. R. O'DETTE: I only know of one that is affected by water.

C. R. HAND: Mr. O'Dette has covered the many problems of turbine lubrication very well. Those of us who are concerned with large or small turbines can recite many experiences which parallel those covered in the paper and then add a few variations.

In some turbine designs, ineffective seals have been one of the bad actors. Seals which permit high pressure steam to pass along the shaft and enter bearings result in deposits of boiler compounds and solids carry over. In some cases, the deposits build up in bearing housings and on shafts. Some of this material is washed away by the oil and adds to the gradual contamination of the lubricant. In some cases, there is no apparent chemical reaction. However, this material accumulates with other solids in the oil reservoir.

Collars were installed on turbine shafts to deflect steam leakage up and away from the bearings have been effective in keeping out water and boiler compounds.

In other cases, rapid formation of acids occur which attack all metallic parts, surfaces of brass and bronze showing the most active reaction. This, in some cases, results in oils turning green. Attempts to remove these acids and compounds and continue operation have been made. Filters of various types, water and steam washing and centrifuges were tried. To date no means has been developed to eliminate these acids and bring the oil back to serviceable condition, without undue costs. The best solution is to get the acidic oil out of the system and thoroughly clean all bearings, governors, reservoirs and piping and put in a new batch of oil.

Proper cleaning and painting of reservoirs, bearing housings and other parts of the system whether they are bathed with oil or not, have shown good results in keeping down the formation of acids. After three years service, these coatings are still intact and no aluminum has migrated into the oil.

Much attention is being given by the designers of new machines to all turbine lubrication problems. Since many used turbines are being overhauled and transferred to new locations, the engineers charged with installing and operating these used turbines can do much to insure continued satisfactory service by applying the information in Mr. O'Dette's paper.

THE WAPAKONETA MACHINE CO.
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The Curran-Knowles Coke Oven

. . . . developed primarily as a means of producing a smokeless fuel, this design combines the simplicity of the beehive oven with the economy of the by-product oven . . . .

by M. D. Curran, PRESIDENT

COAL CARBONIZING COMPANY

ST. LOUIS, MISSOURI

▲ TEN years ago, our company undertook to evaluate by-product coke making processes and to determine the possibility of producing more reactive coke by establishing a different set of conditions to govern carbonization. Consideration was also given to simplifying, if possible, the character of equipment used, providing greater flexibility for intermittent operation, reducing the thermal decomposition of the volatiles liberated from the coal, and reducing the investment cost per ton of coking capacity. These considerations were required in the form of a commercial process for the purpose of producing a smokeless fuel from feebly coking Illinois coals to provide the City of St. Louis, Missouri with a means by which it could eliminate the smoke nuisance. Previous efforts, in which many millions of dollars were employed, met with failure because the coke produced could not be burned satisfactorily in existing stoves and furnaces, and the cost was so high it could not compete with cheap low grade coal. Specifically, it was necessary to produce a coke substance which would be sufficiently reactive that it would give full heat at fuel bed temperatures below the fusion temperature of the ash, about 2000 F, and from an economic viewpoint, the manufacturing cost had to be such that the fuel consumers in St. Louis could get their heat at substantially the same annual cost. This investigation resulted in the selection of the sole flue principle of heating for the reason that a substantial degree of improvement appeared to be assured in respect of each of these factors. The Curran-Knowles oven as constructed today incorporates the experience gained during a ten year period in which 59 ovens in four different plants have been built and their operating characteristics studied.

The design and construction of the oven has been so worked out as to permit the use of fire clay brick throughout, except in the floor and sole flues, where silica brick is used to permit operation at standard high temperatures. For speed of construction and economy, the greater part of the brickwork, including the silica, is composed of standard size and shapes. The use of fire clay brick also provides a flexibility in handling the ovens which is not possible where silica brick comprises the major part of the structure. The oven can be heated up and cooled off without causing any serious damage to the oven structure. We believe this to be a most valuable asset with which to meet conditions which may require temporary interruption of operations.

The carbonizing of coal in the thin horizontal layer by the application of heat in the underside of the charge very substantially increases coking speed. In some cases the rate of coking is practically double that developed in the vertical slot type of oven. Due to the fact that the flow of the products of distillation is in the same direction as the flow of heat through the coal charge — upward — the raw coal receives considerable preheating.

The gases distilled from the coal leave the oven

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 22-24, 1942

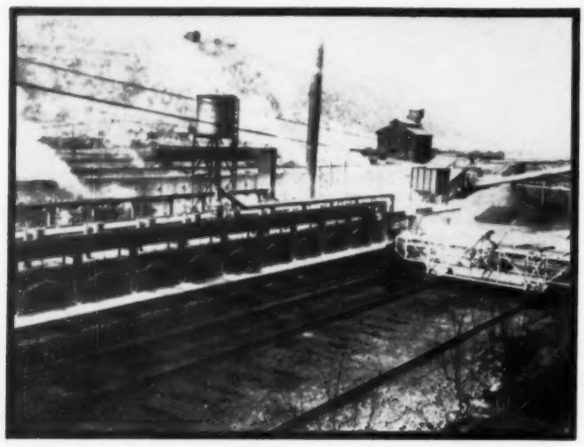

Figure 1 — View of oven battery from the pusher side.

chamber at a temperature approximately 700 F. This permits the use of inexpensive small unlined standpipes, thus affording a substantial saving in cost of equipment required to handle the hot raw gas. The apparatus used for washing and cleaning the gas has been greatly simplified through the use of the station disintegrator, so that the gas cleaning and cooling equipment occupies so little space that it may be installed in the room with pumps and exhausters, thus eliminating a large amount of piping and equipment which is usually required to connect the gas washing and cleaning equipment with the exhauster room.

Regenerators are incorporated beneath the combustion flues, by means of which the products of combustion are reduced in temperature from 2500 F to 500 F prior to their delivery to the chimney. In considering the heat balance of this coke oven, it will be seen that carbonization is accomplished with a minimum of oven fuel gas. Heat recovery is applied on both combustion products and the volatile portion of the coal. In the case of an average coal containing one-third volatile matter, it will be noted that a large saving in heat is effected on account of the fact that one third of the coal charge, which leaves the oven in the form of products of distillation, passes out of the oven chamber at a temperature approximately one thousand degrees lower than is usually the case in retorts and slot type ovens. When this saving in heat loss is combined with the saving resulting from less cracking of the gases inside the oven chamber and the low heat loss incidental to disposing of moisture in the coal, great fuel gas economy is attained.

The auxiliary equipment used in connection with the operation of the ovens is comparatively inexpensive due to the fact that the actual physical work performed in handling the coke is very much less than that required in the operation of the vertical slot type coke oven. For example, the power required to remove the coke charge from the new oven can be supplied by a 25 hp motor as compared to 100 to 150 hp usually required for the slot type oven. The use of metallic conveyors for receiving the hot coke as it is pushed from the ovens and for delivering it through the quenching station very greatly simplifies this phase of the operation. Accurate control of coke moisture is easily obtained so that the use of a coke wharf is unnecessary. The coke leaving the quencher goes directly to a slow moving cooling conveyor which discharges on to a belt conveyor leading to the screening station.

The particular nature of the operation permits the use of small power units. Some of the plants now in operation have been powered throughout with automotive type engines using coal gas as fuel. Aside from the fact that the initial investment is much less than the cost of electric motors, the expense if a steam-electric generating plant is eliminated and the plant runs on its own power at a very low cost. A few hundred dollars invested in repair materials provides the same security as the many thousands of dollars usually required to carry a store's inventory of electrical and power plant spares.

A superior quality of metallurgical coke is produced in this process from either high or low volatile coals or mixtures of the same by controlling the oven operation to reduce the volatile matter in the coke to approximately one per cent. The increased reactivity of the coke produced makes possible improved operating practice in many metallurgical operations including electric furnace reduction, where high electrical resistivity of the coke is a desireable characteristic.

Special comment should be made regarding the effect of carbonizing reaction in this oven on the character of tar produced. Heating the coal from the underside of a relatively thin layer develops a fusion zone which travels vertically and which drives before it some of the volatile constituents of the coal. These volatile substances must be condensed in the cooler body of the coal and redistilled several times during the carbonizing process. Since the gases escape without

Figure 2 — A hot coke conveyor runs along the coke side of the battery.

being subjected to cracking, there is a substantial increase in the amount of tar produced per ton of coal. At the same time, the heat required for carbonization is reduced by that amount of heat which would otherwise be absorbed in cracking the tarry gases.

The reduction in cracking of the gases brings about the production of a very fluid tar containing unusually small amounts of free carbon and pitch. Such naphthalene as is produced is easily carried in solution in the tar so that there is none of the usual deposition of pitch and naphthalene in the gas piping and gas handling equipment. Furthermore, the tar separates quickly and easily from the flushing water and there is no problem of tar dehydration.

In reference to the economic and technical value of tar of this quality, we need no longer discuss its application to the production of synthetic resins as a future development. The time for producing a great variety of these substances, including synthetic rubber, silk, and plastics is here, and the need for a large supply of coal tar oils for these new industries is recognized, and we can therefore afford to examine our coke producing processes with the object of producing our metallurgical coke under conditions which yield the greatest amounts of phenolic oils.

A recent application of the principles employed in heating our coke oven to muffle furnaces for the production of magnesium from dolomite will, I think, be of interest to the steel industry. In this method of producing magnesium, ferro-silicon is used as a reducing agent with calcined dolomite. The thermo-dynamic reaction takes place under vacuum at temperatures above 2100 F. Preferably, in order to develop the fastest reaction speed, the temperature is maintained as near as possible to that at which the metallic retorts in which the reaction is carried on would soften and collapse, thought to be about 2200 F. It is therefore necessary to have an accurate distribution of heat in order to operate at a maximum reaction temperature without jeopardizing the retort. In this application, we use a furnace of standard dimensions having a muffle chamber 8½ ft wide by 40 ft long, into which are inserted twenty 12 in. o.d. metallic retorts. Operating experience establishes beyond any question of doubt the uniformity of heating attained in our coke oven work, for the reason that these muffle furnaces are equipped with radiation pyrometers and facilities for determining temperatures over the whole floor area by means of which we know the maximum variation in floor temperature is not more than 10 degrees.

I mention this application for the reason that muffle furnaces of this type may be of interest where accurate temperature conditions must be maintained in heat treating processes. In connection with the work done on magnesium production, we have found that it is possible to maintain the degree of uniformity of temperature in the furnace floor at temperatures ranging as low as 1500 F and as high as 2150 F.

DISCUSSION

PRESENTED BY

W. T. BROWN, Research Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

J. D. DAVIS, Senior Chemist, United States Bureau of Mines, Pittsburgh, Pennsylvania

J. E. MACONACHIE, Coal Carbonizing Company, St. Louis, Missouri

W. H. COLLISON, Superintendent, By Product Coke Plant, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

H. H. LOWRY, Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pennsylvania

D. P. FINNEY, Division Superintendent, Carnegie-Illinois Steel Corporation, Clairton, Pennsylvania

H. T. WATTS, Combustion Engineer, Republic Steel Corporation, Gadsden, Alabama

W. T. BROWN: I have seen the ovens in operation. We have sent coal out there and tried it out — 100 per cent low volatile, highly expanding coal from the Lower Kittanning seam, and it seemed to make pretty good coke.

J. D. DAVIS: Are the later type ovens usually built with a carborundum floor, or is that silica?

J. E. MACONACHIE: We are using the silica floor for the coke oven. It is only in the magnesium furnaces, for better transfer of heat to the melting chamber, that we are using carborundum with its greater thermal conductivity.

W. H. COLLISON: About what coking rate, that is inches per hour (with the understanding that you are heating from only one side), do you have in those ovens?

J. E. MACONACHIE: About an inch and a quarter an hour, heating from the one side, of course, as we do. The Millstadt plant, with a coal averaging 20 per cent moisture, arriving from a strip mining operation nearby, is on a 10-hour coking schedule, coking 11 inches of coal containing 20 per cent of moisture at that speed. When we say that the coking speed is fast, of course we mean that the coking of 11 inches of coal in eleven hours or ten hours is affected by heating from one side only.

H. H. LOWRY: May I ask a question about the temperature distribution through the coke when it is pushed? The coke on the hearth unquestionably reaches the temperature of the hearth, but what is the temperature 11 inches away from it? Is it 700 degrees, the same as the roof, or is it some intermediate temperature?

J. E. MACONACHIE: I think I can best answer the question by saying that the full charge is devolatilized to, say, one per cent, if we are making a metallurgical grade of coke. A domestic grade of coke is pushed deliberately 15 or 20 minutes earlier, leaving 4 or 5 per cent of volatile matter in the top inch or inch and a half of the charge. If the final temperature reached by the top of the charge depends upon the amount of overcoking, that is allowed, of course. The uniformity of heat distribution over the floor is such that the devol-

(*Please turn to page 50*)

"Shutdowns Ended

at Hercules Foundries, Inc., After

Read This, **IF YOU HAVE PRODUCTION TROUBLES**

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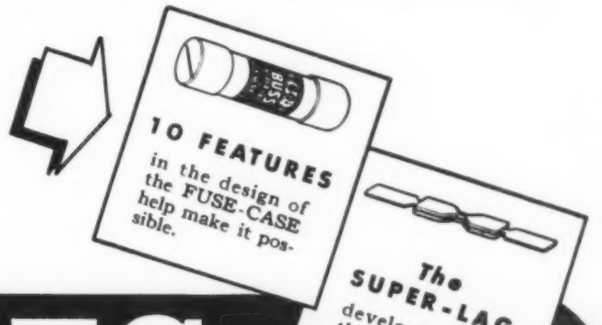
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atilization at any spot is proceeding in step with the devolatilization at any other spot, so that the reaching of the temperature in the top half inch is sudden.

The products of distillation, of course, come off at higher temperatures than the 700 that I mentioned for that period of time in which the devolatilization is just breaking through the top of the charge, but during that period of time there is a very small production of products of distillation so that the volume produced per minute is low at that time, and rather than an increase in the temperature of the gases in the stand pipe, we observe a decrease, the reason being that those gases are now traveling slowly and they have time in the large space under the arch of the furnace to cool off before reaching the stand pipe.

H. H. LOWRY: Does the rate of coking depend upon whether you are making a metallurgical coke or domestic coke? Does that last 4 per cent of volatile that you get out of the top take longer than the rest of the operation?

J. E. MACONACHIE: No. I think if you refer to Mr. Gilbert Thiessen's paper in Industrial and Engineering Chemistry back in 1936, you will see that the temperature distribution in the coal charge, as carbonization is proceeding, proceeds very steadily throughout the coking cycle. The insulating effect, we will say, of 8 or 9 inches of coke below the top 3 inches of coal that are waiting to be coked is apparently not great. It is compensated for during the carbonization cycle by the rise in temperature of the floor itself. Of course, the floor gets a thermal shock when the green coal is dropped on it, and during the twelve hours that the charge is in the oven, the temperature in the combustion flue, and of course the floor, is constantly rising, so that we have farther for the heat to travel from the floor to the coking coal, but the top of the temperature gradient through that is increasing all the time and it tends to compensate for that factor.

D. P. FINNEY: Do you encounter any serious difficulties in the operation of these ovens as the result of the heavy deposition of carbon on the floor?

J. E. MACONACHIE: We have observed a carbon production on the floor and the influence of various factors on it, and I will sum up what we know about it now in this way. It isn't great because that carbon originates from the cracking of volatiles, largely after they have left the coal. Since in this oven we don't get much of that, we don't get much carbon formation. With a very wet coal and higher rates of carbonization, we get more than with a drier coal and slower rates of carbonization. In all but the one plant in Illinois that handles this very high moisture coal, it is possible to control the carbon layer on the silica floor to the thickness desired. In other words, we think it is good sense to leave a quarter of an inch or so on there to take the wear of the moving coke. With more than that, it begins to interfere with the flow of heat through the floor to the charge.

By outfitting the pushing machine with a decarbonizing pipe — simply a perforated pipe running immediately behind the pushing ram, across the oven — and blasting the floor with air through that pipe when the coke is being pushed, the carbon amy be controlled. A plant up in British Columbia is handling a coal, the fines coming from a mining operation immediately adjacent to the location of the battery, and the coal is received in a very dry condition. In the operation of these ovens a decarbonizing attachment is used for three shifts until the carbon gets thin; then, within the discretion of the superintendent, it is cut off for one shift and the carbon is allowed to build up a little bit, thus it is possible to maintain the carbon thickness as desired. If for any reason the carbon builds up to a very thick layer, it has to be removed in the usual way of leaving an oven open for a cycle and allowing it to burn off.

I will say that if it is allowed to approach thicknesses greater than an inch or an inch and a half, which of course constitutes gross malpractice, its contraction and expansion characteristics being so different from the silica floor, it will flake off in big slabs and it does at that time pull silica off the floor with it. That, of course, constitutes gross malpractice and is not, I think, inherent in the carbonization process.

W. H. COLLISON: What do you consider to be the maximum size oven practicable?

J. E. MACONACHIE: The oven that has been operating at Millstadt now for four years handles 9¼ tons in a charge. That is an oven approximately 10 feet wide by 40 feet long. We are building fifty-four ovens up in Hamilton, Ontario at the present time and they will be 10 feet wide and 44½ feet long, with an increase in the coal charge to something like an even ten tons; by the way, an 18-oven battery.

H. T. WATTS: Reference was made to the economy of the oven in the use of fuel and I would like to inquire what percentage of the total fuel produced in gas is used for heating the oven.

J. E. MACONACHIE: Expressed as a percentage, it depends on the coal you are coking, whether high or low volatile. Expressed in terms of actual Btu per pound of coal and coke, our experience is that it averages approximately 2,000,000 Btu per ton, varying, of course, with the character of the coal, its moisture content, etc.

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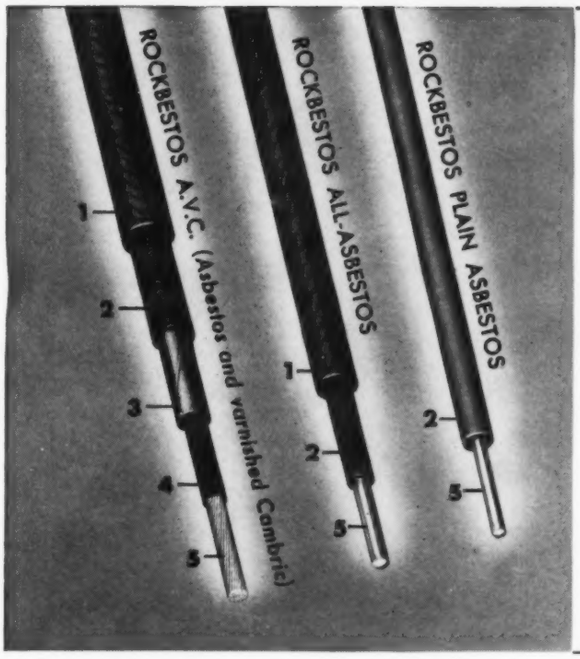

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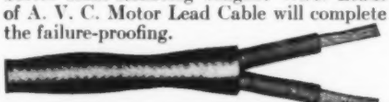

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600 VOLT A.V.C. BOILER ROOM WIRE—TABLE C
(Underwriters' Type AVA)

Sizes No. 18 to 4/0 A. W. G. This construction for sizes 18 to 8, sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A. V. C. construction is ideal. Also for locomotive panel wiring and for switchboards requiring an asbestos braided wire.

THERMOSTAT CONTROL WIRE—TABLE TC

Sizes No. 14, 16 and 18 A. W. G. in two to six conductors with 12½, 25 or 31 mil wall of felted asbestos insulation and cadmium plated steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its lifetime insulation and rugged steel armor will give you trouble-proof circuits.

600 VOLT ALL-ASBESTOS RHEOSTAT CABLE—TABLE R
(Underwriters' Type AI)

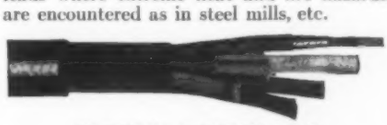
Sizes No. 18 A. W. G. to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.

600 VOLT A.V.C. MOTOR LEAD CABLE—TABLE L
(Underwriters' Type AVA)

Sizes No. 18 A. W. G. to 1,000,000 CM insulated with two walls of felted asbestos and a high-dielectric, heat-sealed varnished cambric insert, covered with heavy asbestos braid.

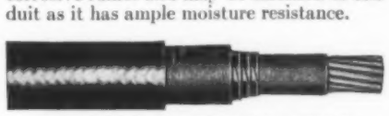
Heatproof, fireproof, greaseproof and oilproof, will not dry out and crack, won't burn or carry flame, and remains permanently flexible. For coil connections, motor and transformer leads where extreme heat and fire hazards are encountered as in steel mills, etc.



600 VOLT A.V.C. CONTROL CABLE

In one to 19 conductors. Standard stranding A. W. G. No. 12—19/No. 25 and No. 9—19/No. 22. Other strandings furnished.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.



600 VOLT A.V.C. POWER CABLE—TABLE E
(Underwriters' Type AVA)

Sizes No. 18 A. W. G. to 1,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 8000.

Recommended for power circuits and hot spot wiring in or around boiler rooms, steam tunnels, soaking pits, tenter frames, glass plants, etc. The asbestos and heat-sealed varnished cambric construction has ample moisture resistance and withstands high temperatures.

Rockbestos Products Corporation, 889 Nicoll Street, New Haven, Conn.

WON'T bake brittle, bloom, burn or rot—RESISTS heat, moisture, oil, grease and fumes

ROCKBESTOS

The Wire with Permanent Insulation

Ignition Furnace for continuous type Sintering Machine. One of McKee's specialized features.

Ore Beneficiation

McKEE engineering for ore beneficiation is based on sound fundamental knowledge of the problems and requirements of the blast furnace operator as well as the ore producer.

McKee engineering, from mine to finished product, takes into consideration all chemical and physical factors of your raw material in designing ore treating plants to produce results to meet your exact requirements.

Thirty-six years of designing and building for the iron and steel industry have built a valuable fund of McKee experience which is available to you through this organization.

McKEE offers you *all* of the highly specialized technical services necessary for the efficient design and construction of plants and equipment for:

CRUSHING
SCREENING
CONCENTRATING
BLENDING
SINTERING

The flexibility of our organization enables us to handle any of the various phases of your project or to undertake the entire project regardless of size.

Arthur G. McKee & Company

★ *Engineers and Contractors* ★

2300 CHESTER AVENUE • CLEVELAND, OHIO

30 ROCKEFELLER PLAZA, NEW YORK, N. Y. • COMMERCE BUILDING, HOUSTON, TEXAS

NEW PHOTOCOPY MACHINE MAKES EXACT DUPLICATES OF DRAWINGS OR RECORDS

▲ With new employees in old positions, and old employees under new burdens, the fool-proof new Apeco photocopy machine comes to the rescue of harassed management, quickly reproducing government reports, statistics, duplicates of orders, extra copies of blueprints and tracings, etc.

Most interesting feature of the Apeco photocopy machine is its simplicity of operation. No skill is required to produce perfect photocopies of anything printed, written, typed, drawn or photographed, and any new, inexperienced boy or girl can take over the job with a few simple instructions. No supervision is needed; the new employee can begin work at once, releasing stenographers, typists and draftsmen — as well as their equipment — for other work.

The new Apeco photocopy machine has almost no working parts and presents practically no repair or maintenance problems. It is so small it can be set up on any desk or table, anywhere in the plant or office, and no darkroom is needed. The machine makes same size copies of anything up to 18x22 inches.

Because copies are photo-exact, no proofreading or comparison is necessary. Hence executive departments use it to copy important letters, contracts, agreements, and confidential memoranda. The sales department makes copies of inquiries and correspondence from customers. The engineering department uses it to make copies directly from blueprints without first making tracings. They also use it to copy specifications, and to duplicate every type of paper work that will speed production and save man-hours. The comptroller uses Apeco to copy financial records and statistics. Many firms are using it to make copies of all vital papers for safe-keeping, as insurance against fire, theft, sabotage and air raids.

The device is remarkably rapid in operation, enabling a single employee to do the work of a dozen people, and do it with absolute, unfailing accuracy. It is now in use by major airlines, war plants, and large and small industries.

Literature: Additional information on the photocopy machine may be obtained from the manufacturer: American Photocopy Equipment Company, 2849 N. Clark Street, Dept. 189, Chicago, Illinois.

Rapid and simple in operation, this photocopy machine has wide application for copying records as a protection against fire, theft, etc.

MODIFIED PRACTICE FOR BULLET CORE STOCK PROCESSING

▲ As a result of the metallurgical and inventive genius of the technical and metallurgical men of American Steel and Wire Company, U. S. Steel subsidiary, cold drawn steel bars for bullet cores are flowing out of the plants of the company in amounts never surpassed or even equaled anywhere at any time.

At the same time; other materials and facilities have been released for a number of purposes, thus effecting a two-fold contribution to America's war effort.

The American Steel and Wire Company has developed a cold drawn bar from open hearth steel which has proved suitable for use in the core, or "stinger," of machine gun ammunition. Previously specifications called for electric furnace steel and centerless ground bars, capacity for production of which was limited by lack of centerless grinders. The use of cold drawn open hearth steel bars permits greater production of bullet cores, the requirements for which had grown beyond the capacity of the nation's electric furnaces to produce. Thus, more electric furnace steel has been released for other uses. At the same

time, the substitution of cold drawn bars has eliminated the necessity of producing centerless grinding equipment, in addition to releasing existing capacity for other purposes.

The primary requisite for the production of bullet core material is close control in all manufacturing stages, from the steel to the finished product. Only carefully selected materials are charged into the open hearth furnaces and subsequent refining of the heat is under close metallurgical control. A high degree of care is exercised in handling and treating the steel and in preparing the billets for rolling into rods. The rods are then heat treated, under rigid control, and cold drawn into bars, resulting in a product of high machinability.

Although the process has necessitated the introduction of many revolutionary practices, the installation of a minimum of new equipment was required. The net gain in increased output and in release of other materials and facilities for various purposes has been of inestimable value in the production of other armament.

REDUCER TYPE TRANSMISSION MAKES VARIABLE SPEED DRIVE OF CONSTANT SPEED MOTOR

▲ A new unit in the line of variable speed control equipment built by Reeves Pulley Company, Columbus, Indiana, is the Reeves reducer-type transmission.

This drive, which consists of the standard Reeves variable speed transmission with built in speed reducer, has been developed to meet the many requirements for accurate speed control and speed reduction combined in one compact completely enclosed unit. An outstanding advantage of this Reeves drive is that far less mounting space is needed to obtain the lower range of speeds which formerly required the use of auxiliary speed reducing equipment.

The Reeves reducer-type transmission is available in two enclosed designs — horizontal and vertical, which may be mounted in any convenient or desired position. Each design is available in a wide range of speeds and in capacities from 1 to 7½ horsepower inclusive. The transmission in various sizes produces ratios of speed variation from 2:1 through 12:1 and the reduction gears provide ratios up to and including 6.9:1. Speed changes are effected by turning a handwheel or, if completely automatic regulation is desired, it is available by mechanical or hydraulic methods.

The reduction gears are mounted on the variable shaft of the transmission, this shaft serving as the input shaft for the reducer unit. The assembly of the reducer unit may be made in many different positions.

The gear reduction unit, which is built integral with the transmission, has been especially developed for the severe torque demands of variable speed service. It is the same unit in single reduction type that has proved itself in thousands of applications of another basic Reeves drive, the Vari-Speed Motodrive. Designed for as compact mounting as possible, allowance has been made in size for overload in starting and momentary peak loads. The shafts of the reducer, proper, are mounted on heavy duty ball radial bearings and are manufactured from high carbon steel.

The helical type of gear reducer has been adopted because of established high efficiency and quiet operation. Since the teeth of a helical gear are cut at an angle to the axis, two or more teeth are in contact across the face of the gear at all times, this providing smoother transmission of gear load from one tooth to the next, producing better load distribution and improving the wearing properties of the gear. All rotating parts in the reducer are splash lubricated. Three oil plugs are provided, one for determining the oil level, one for filling and one for draining the oil.

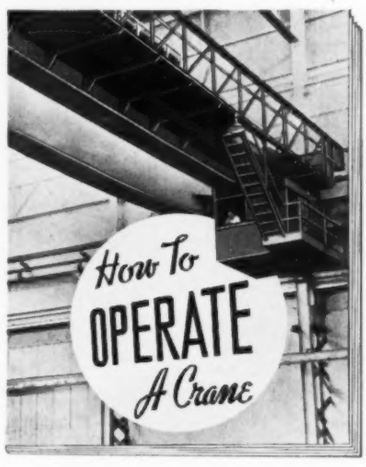
The Reeves reducer-type transmission in either horizontal or vertical design may be equipped for individual motor drive by use of a Reeves motor base. The motor mounting is directly above the transmission, the motor base being attached to the top of the transmission frame. This base is universally adjustable to accommodate any standard make of motor of the correct horsepower capacities for any given size of Reeves reducer-type transmission. Connection between motor and constant speed shaft of the Reeves drive may be either silent or roller chain and sprockets, multiple V-belts or pinion and gear.

This reducer type transmission is equipped with adjustable motor base which accommodates any standard constant speed motor for individual drive.

INSTRUCTION BOOKLET FOR CRANE OPERATORS

▲ The necessity of using inexperienced personnel, including women, to operate cranes has created an additional problem for crane users. To aid in the training of these new employees, the EC&M Company has prepared a new 48-page, two-color booklet, on "How to Operate A Crane." Amply illustrated with nearly 70 drawings, photographs, etc., this booklet has

Giving operating and maintenance information on overhead cranes, this booklet is particularly valuable in training new operators.



been designed to give the operator a more thorough understanding of the machine he handles — to impress upon him the importance of taking care of the investment that has made his job possible — to pass on hints, tips and cues, describing and illustrating methods by which he can produce more safely — to indicate how proper operation will reduce delays and keep down repair costs — to caution him by word and by picture of the perils of unsafe operation and the necessity for reporting excessive wear, faulty operation, etc., immediately. Most crane users, will find this booklet helpful not only in training new employees, but likewise beneficial in improving the quality of performance from the more seasoned operator. Copies of this booklet may be obtained by addressing the Electric Controller and Manufacturing Company, 2700 East 79th Street, Cleveland, Ohio.

TO BROADEN FIELD FOR PNEUMATIC CONTROL

▲ The accumulated experience of Westinghouse Air Brake Company in the development and manufacture of pneumatic controls for the railroads of the world now is to be made available to the general industrial field, it is announced by George A. Blackmore, president.

The company's remote control systems already have been installed in the marine field for the control of ships. Similar applications have been made on power shovels in the earth moving industry, and to help solve control problems in the mining, petroleum and machine tool industries.

Among other industries being studied under the broadened industrial program of Westinghouse Air Brake are those requiring accurate, flexible controls involving a sequence of operations, such as agricultural machinery, armament equipment, automotive, aviation, building construction, ceramic, lumbering, metal working, paper manufacturing and plastic.

Development work on the new remote pneumatic control systems, supplemented when necessary by the adaptation of pneumatic-hydraulic and pneumatic-electric controls, is being done by the engineering staff of the company at Wilmerding. The new systems will be marketed by the company's industrial division.

ARMY-NAVY "E" AWARDED TO PITTSBURGH STEEL

Proudly displaying the Army-Navy "E" pennant awarded to two plants of Pittsburgh Steel Company, March 18, are left to right, Lt. Col. Ralph L. Dunckle, B. E. Sance, J. H. Carter, H. A. Roemer, E. J. Protin and Commander Carl E. Egeler.

STEEL LABOR ADVISORY COMMITTEE URGES FORTY-EIGHT HOUR WEEK

▲ A 48-hour work week throughout the steel industry was urged by the steel labor advisory committee recently at its first meeting with steel division officials, in order to provide the manpower for increased productive facilities, and to compensate for the loss of workers to the armed services.

The committee, consisting of President Philip Murray of the CIO and of the United Steel Workers of America, and six other USWA officials, was appointed by WPB earlier this week to work with the steel division and industry toward securing the maximum production of steel for winning the war.

The meeting was given over to preliminary discussions of the 48-hour work week, and of related questions such as temporary dislocations of employment resulting from shifts in armament production, and the loss of thousands of workers to the military forces.

Formal recommendations on these questions to Steel Division Director H. G. Batcheller are now being prepared by the Committee. The recommendations will be discussed with the steel industry advisory committee at its next meeting, and further examination of the problems involved will be made by the two committees working with the division.

Mr. Murray said that a survey made by the union indicated that the armed forces had absorbed approximately 186,000 workers from steel and steel fabricating plants, of which 90,000 to 100,000 came from "basic steel."

As a result of these losses, the further movement of men from industry into the army and navy this year, and the need for more workers required by expansion of steel capacity, the industry faces a serious manpower situation.

Harold J. Ruttenberg, assistant to the director of the steel division, and former research director of the USWA, estimated that about 50,000 workers in addition to draft replacements

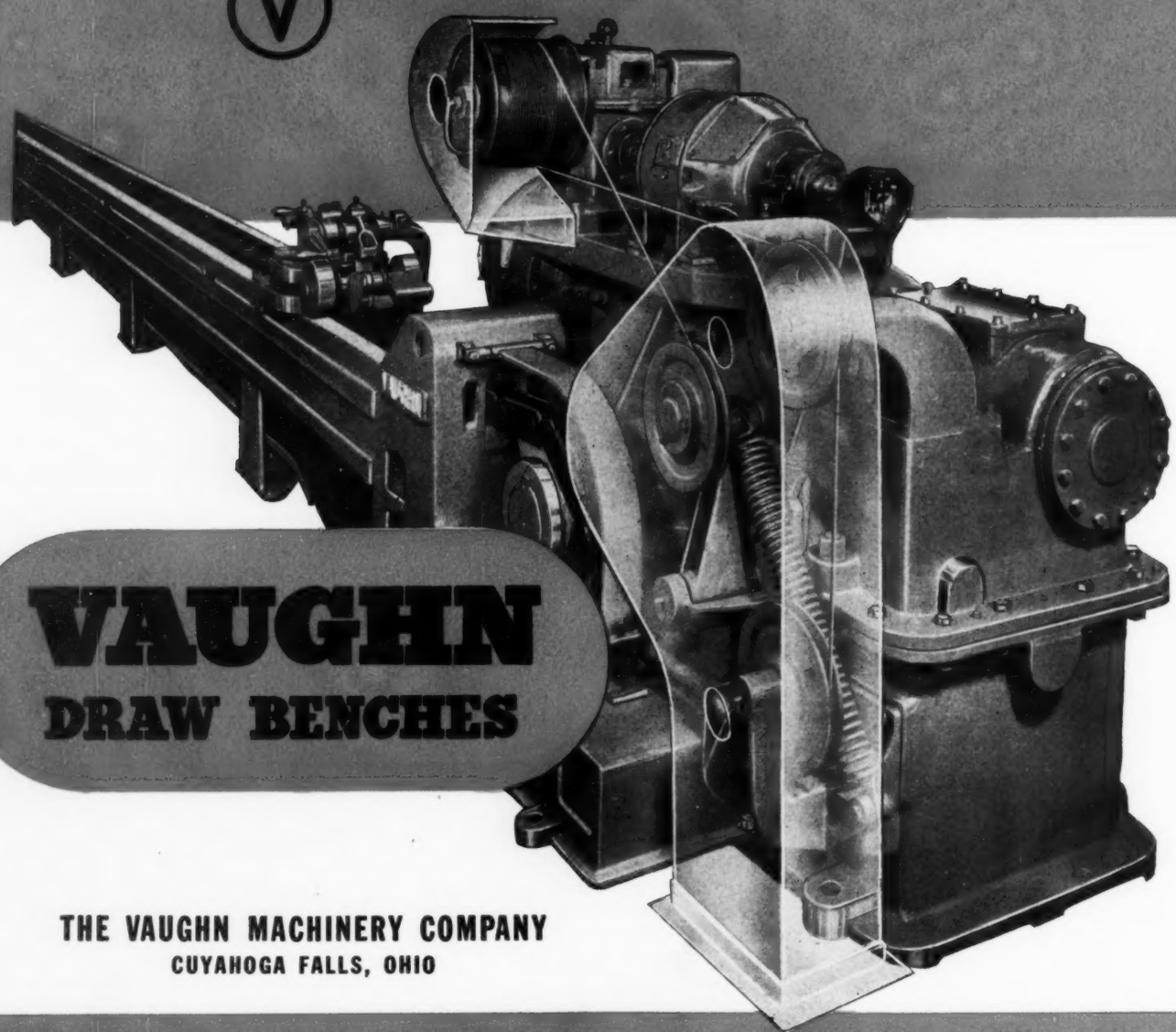
MAJOR ELEMENTS IN VAUGHN DRAW BENCH *Victory* PERFORMANCE

Compact, fully enclosed, anti-friction drive with carriage return mechanism on top

Single or double mandrel for tubes

Tong or block-type carriage

Arranged for 1, 2, or 3 dies for bars



VAUGHN
DRAW BENCHES

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO

COMPLETE COLD DRAWING EQUIPMENT: Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

would be required by the steel industry as a result of expansion scheduled to be put into operation this year. In January, 1943, there were 521,000 production and maintenance workers in the basic steel industries.

The committee pointed out that to date, the war manpower commission has established the 48-hour work week only in areas designated as critical labor shortage areas.

According to Government data, the average work week in the steel industry during December, 1942 was 41½ hours. Allowing for injuries, and other unavoidable occurrences of a similar nature, a 48-hour industry wide work week would men actual operations averaging about 46½ hours.

Mr. Batcheller told the committee that the "bottleneck" in steel has now shifted from plates to alloy steels and forging quality carbon steels, and that every effort is being made to step up production of those items.

As for plates, Mr. Batcheller said, no war production program — ships, tanks, or other equipment — is being delayed because of inadequacy of plates. "We are now supplying plates at a rate of approximately 1,150,000 (million) tons each month," he added.

COMING MEETINGS FOR STEEL MEN

▲ The 26th annual conference of the National Open Hearth Steel Committee and the Blast Furnace and Raw Materials Committee of the A.I.M.E. Iron and Steel Division will be held April 28th-29th, at Hotel Statler, Cleveland, Ohio. The program scheduled for this meeting will deal exclusively with the manifold problems involved in sustaining capacity production of quality pig iron and steel.

Melting foremen, melters, and first and second helpers on electric furnaces will have an opportunity to discuss electric furnace steel making problems in special sessions of the Electric Metal Makers Guild sectional meeting at the Hotel Morrison, in Chicago, on May 1.

The Guild is admitting these men, even though they are not members, to its sectional meetings as a training aid because of the rapidly increasing growth of electric furnace capacity in the United States. However, the meeting will be restricted to workers in the stated positions.

Two separate conferences, one on ingots and one on castings, will meet during the day followed by a joint session in the evening. Round table discussions will follow the special group meetings.

Guild President Harry F. Walthers, of Timken Steel and Tube has also announced that Canton, Ohio, will be the site of the annual meeting of the Guild, on June 4 and 5. Co-chairman on arrangements for the two-day meeting are Walter Farnsworth, of Republic Steel Company, Canton; Leroy Bash, of Timken Steel and Tube, Canton; and Chester Williams, of Massillon Steel Castings, Massillon, Ohio.

There will be a joint meeting of the castings and ingot divisions on Friday morning, June 4, with separate gatherings for the two groups in the afternoon, followed by the annual business meeting Friday evening. Separate sessions will again be held Saturday morning, with a combined meeting in the afternoon. The annual banquet on Saturday evening will close the sessions.

Edward Chelius, of the Duquesne Works of Carnegie-Illinois, is chairman of the ingot division, and Martin McDonough, of National Malleable and Steel Castings, Sharon, Pennsylvania, is in charge of the castings division. James C. Sweitzer, of Sivyer Steel Castings Company, Milwaukee, is vice-president of the Guild, and John E. Arthur, of Crucible Steel Company of America, is secretary-treasurer.

TRUCK MANUFACTURER ADVANCES RULES FOR RUBBER TIRE CONSERVATION

▲ Operators of this country's 30,000 power industrial trucks can help save war-precious rubber by following five simple tire conservation rules worked out by the Elwell-Parker Electric Company service engineers.

The rubber problem for these trucks is so great Elwell-Parker engineers have been collaborating with rubber company research men to develop tires made of new compounds. Conservation is also necessary because, with the trucks and tires being used around the clock every day in the week in many war plants, tires are wearing out much faster than in normal times.

Elwell-Parker's service engineers, who are located in all of the big industrial centers, carefully analyzed the actual conditions under which these tires are used. As a result, the company has formulated these five rules for operators of its own and other makes of trucks to follow to get more miles of wear from their tires:

1. Avoid broken glass and sharp metal chips. Tires can be ruined in a few days by having pieces of rubber gouged out by sharp pieces of material.

2. Stay off the curb. Short cuts, in the long run, don't save time. Running tires over obstructions chews up rubber and tears the tires off rims. It may also damage the truck.

3. Keep out of chock-holes. Avoid depressions and cracks in the floor or pavement. Jolts help destroy tires.

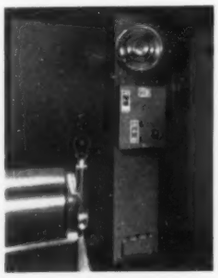
4. Keep out of oil. Oil and grease attack rubber. Tires should be cleaned periodically.

5. Start slowly. Rabbit-jump starts can tear miles from tires by grinding off the rubber.

These views might be captioned "What not to do" or "Help the Axis through this practice."

PROTECTION FOR CRANE OPERATORS FROM DUST AND GAS

▲ A new Aire-Rectifier, patents applied for, for protecting overhead crane operators from harmful dusts, vapors and gases causing occupational diseases is announced by The Lintern



Corporation, 54 Lincoln Avenue, Berea, Ohio. A unique arrangement of mechanical, activated carbon and electro static Westinghouse Precipitron filters are combined in a compact assembly to completely treat all air entering the cab enclosure.

Clear fresh air enters the cab at the rate of one complete change per minute, through a diffuser efficiently preventing drafts. Where excessive heat complicates the health problem, mechanical cooling is provided. For winter operation, the filtered air is electrically heated. Filtering apparatus is easily removed periodically for cleaning. The Aire-Rectifier is easily applied to any crane.

MARCH STEEL OUTPUT SHATTERS ALL RECORDS

▲ The nation's steel industry during March operated at 100 per cent of capacity and turned out 7,670,187 net tons of steel ingots, an all-time record high, the American Iron and Steel Institute's monthly report revealed.

The total exceeded by nearly 90,000 tons the previous record of 7,579,514 net tons produced in October, 1942, when the industry also operated at what then was its rated capacity. The March figure compared with 6,826,049 tons in February, and 7,392,111 tons in March, 1941.

Average weekly output of 1,731,419 tons in March also set a new record and compared with an average weekly of 1,705,512 net tons in February, and 1,668,648 tons a year ago.

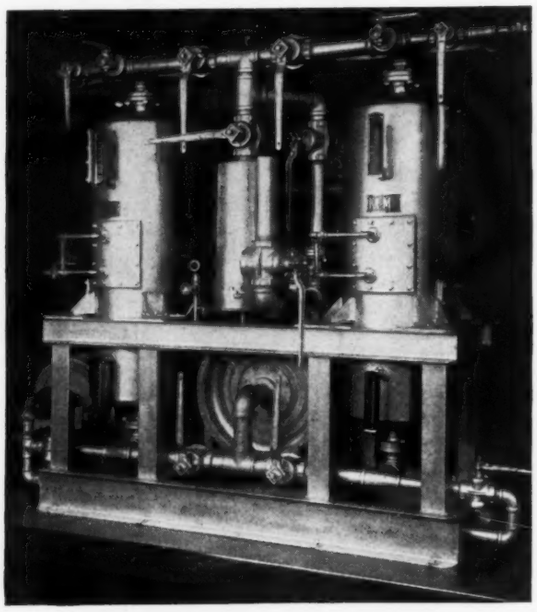
Production for the first quarter of 1943 amounted to 21,920,278 net tons, a new high for a first quarter but a total exceeded in the last quarter of 1942 when output was 22,063,866 tons. The total in the first quarter last year was 21,016,752 tons.

REPUBLIC STEEL

▲ Republic Steel Corporation reported that its production of coke and pig iron in March had set new company records and its steel ingot output had reached 103.1 per cent of the theoretical capacity.

The corporation said coke production was 464,233 tons last month, compared with the previous peak of 416,415 tons in January, 1942, while pig iron production was 502,587 tons compared with the previous record of 482,265 tons last October.

The development of a special steel,



for

DRY

ANNEALING ATMOSPHERES

KEMP SILICA GEL DEHYDRATORS

guarantee the *exact* degree of dryness you need in *your* annealing atmospheres.

Designed by gas equipment engineers; and proven by an impressive record of dependable and economical operation in plants demanding constant and exact drying of annealing atmospheres.

Write **The C. M. Kemp Mfg. Company, 405 East Oliver Street, Baltimore, Maryland—ask for Dryer Bulletin.**

STANDARD UNITS BUILT TO GIVE:
Capacities: 10 to 100,000 c.f.m.
Pressures: Atmospheric to 2500 lbs. per square inch
Adsorbent: Silica Gel, high capacity, long life
Activation: By gas, electricity, or steam, as desired
Types: Single or twin towers for intermittent or continuous operation

The Army-Navy E Flag, awarded "for high achievement in the production of materials of war", proudly flies at the C. M. Kemp Mfg. Co.

KEMP of BALTIMORE

used for making cartridge cases was one of the metallurgical accomplishments of Republic described in a recent letter to Republic stockholders. It was necessary to perfect a steel which had high drawing qualities, great elastic recovery and good corrosion resistance. The company started from the open hearth and perfected new practices, with new rolling and annealing procedures.

The letter also pointed out that Republic made two notable contributions in the field of light armor plate: first was the method by which the plates are heat treated and processed in a continuous production line and, secondly, an improved method of shaping and cutting armor plate into pieces which can be welded together to make a finished tank body.

INLAND STEEL

▲ Monthly production of ingots at the Indiana Harbor plant of the Inland Steel Company reached an all-time high during March, the previous record having been topped by 7749 net tons. In addition to the ingot production mark, 14 additional plant production records were established in March.

BETHLEHEM STEEL

▲ Bethlehem Steel Company produced 1,113,500 tons of steel ingots last month, a new monthly record, according to an announcement made recently by Eugene G. Grace, president. The March record exceeded by 16,000 tons the company's previous high mark, set last October. The company's steel-making plants operated at 101.1 per cent of rated capacity.

"It should be pointed out," Mr. Grace said, "that this record was established in a period when about one-third of our output consisted of alloy and other special high-quality grades of steel for military uses which require more time in processing then ordinary steels."

JONES AND LAUGHLIN

▲ Indicating what can be done with existing equipment (and for that matter old equipment), the Jones and Laughlin Steel Corporation's 44 in. blooming mill at its Aliquippa Works rolled 171,440 tons of ingots in March. This is believed by the company to be a new record, the previous one said to have been made on the same mill in October, 1942, when 161,074 tons of ingots were rolled.

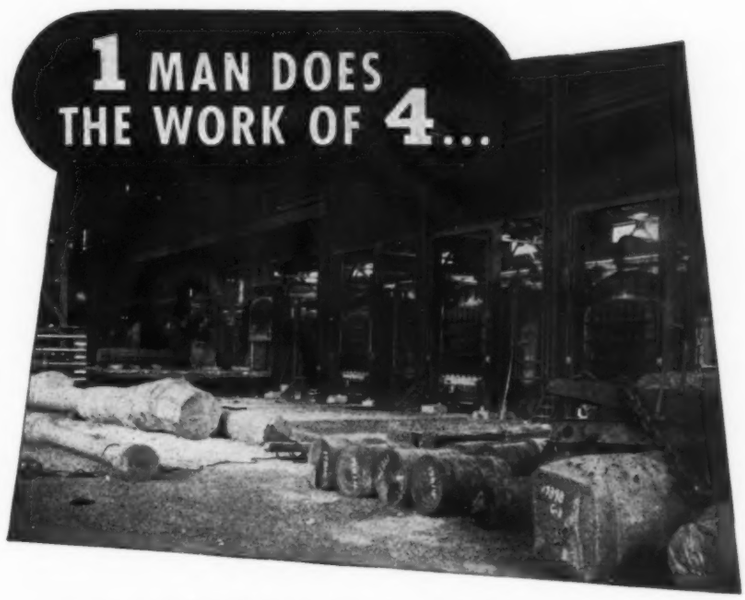
The blooming mill was constructed in 1910.

The company also claims a world's record for Aliquippa's No. 3 blast furnace which was said to have produced 48,505 tons of iron, averaging 1565 tons a day during March. According to the company, this blast furnace was built in 1910, and is said to be equipped with ordinary old-style blowing equipment.

ANNOUNCES NEW A-C WELDING ELECTRODE

▲ A new all-position alternating-current electrode for electric welding, known as Murex type A, has been developed by the Metal and Thermit Corporation, New York. With this new a-c electrode, overhead and vertical welds can be made without the use of a highly specialized welding technique, according to the manufacturer.

Murex type A electrodes meet the requirements for Grade E-6011 electrodes, under A.W.S.-A.S.T.M. specification A-233-42T, for grade III,



WITH THE RYAN ELECTRIC DOOR LIFT
AND AUTOMATIC CONTROL

The above illustration is typical of the war production jobs which Ryan Electric Door Lifts and Automatic Controls are doing. In this plant — as in scores of other vital heat-treating industries — the Ryan Electric Door Lifts and Handling Equipment enable 1 man to handle the work formerly done by 4.

Charging and discharging operations are performed with precise timing, minimum heat losses, and maximum quality in the finished product.

Ryan Lifts and Controls are installed in a few hours on either new or old installations. A new complete technical Bulletin forwarded on request.

Conserve time . . . . CONSULT RYAN!

ENGINEERED FJR EQUIPMENT

FRED J. RYAN COMPANY
LOCATED IN A PHILA. SUBURB . . . WYNCOTE, PA.

classes 1 and 2, under U. S. Navy Bureau of Ships specification 46E3, and for grades H1G, B1G and E2G, American Bureau of Shipping, the manufacturer states.

The new electrode is available in $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, and $\frac{3}{16}$ in. sizes. Typical physical properties of the weld metal, as welded, include yield points of 52,000 to 61,000 pounds per square inch, ultimate strength of 62,000 to 71,000 pounds per square inch, and an elongation of 22 to 26 per cent in two inches.

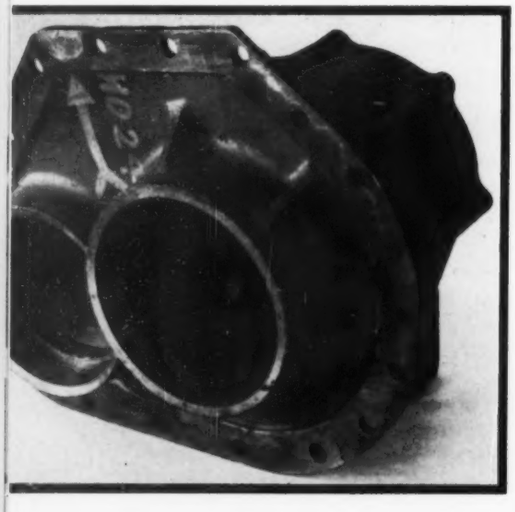
SALVAGE BY LOW TEMPERATURE WELDING

▲ Millions of dollars of castings and parts already machined are scrapped every month in our war plants. Some plants already have started a salvage program. Most of these are using Castolin Eutectic Alloys because of the great adaptability of these alloys for such work.

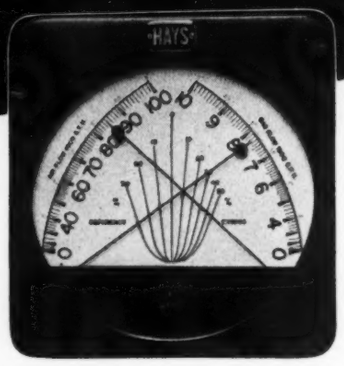
The Castolin Eutectic Process is a true low temperature welding operation by which alloys having a close matching composition with the parent metal are applied with a new technique similar to brazing. The finished weld cannot be detected, and is a really true weld. The advantages of being able to operate at such low temperature are obvious because of the fact that less heat is used, delicate or machined castings will not warp, and no stresses will be created. The parent metal will not be affected by high temperatures, as it is only heated moderately, thus its physical properties of the metals are unchanged. Structure changes in particular are avoided. The operation is simple — it consists of chamfering or chipping out the defect, applying a specially developed flux (marketed as Castolin Autochemic Flux), heating up the neighborhood of the defect with an oxy-acetylene torch. At a low temperature, which is indicated by the fusion of the flux, the specially developed Castolin Eutectic Rod is applied. It will flow smoothly and a very small amount is required.

The method is nearly fool-proof and unskilled welders obtain good results almost immediately. The finished weld can be easily machined, as there is no hard fusion line. As mentioned previously, the physical properties of this welded metal closely match that of the parent metal. In the chemical composition, the hardness, tensile strength, and corrosion resistance are superior to the parent metal itself in most instances. The technique and complete instructions are available from the manufacturers

This alloy steel casting, salvaged with Castolin Eutectic Alloy No. 24, is completely machinable.



Are you interested in Saving



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MATERIAL

This Gage will do it!

HAYS VISIO-RATIO GAGE

IT SAVES IN MAN POWER because it eliminates the necessity of making calculations to determine air excess or deficiency—does away with lost time in making experimental adjustments.

It saves in fuel because it indicates instantly when there is an incorrect proportioning of air and fuel. It is an infallible guide to highest possible combustion efficiency.

It saves in material through producing greater uniformity in production methods, in minimizing spoilage, etc. It may be used for indicating not only the ratio of air flow to fuel flow—but the ratio between other functions such as pressure, draft, suction, temperature (up to 1000° F) speed in R.P.M. or inches per minute, position, level and others.

The cross-pointer feature is exclusive with the Hays Visio-Ratio Gage. It shows at a glance not only the amount of the two flows but the percentage of excess or deficiency existing between them.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

Send for
PUBLICATION 41-478
ON CENTRALIZED
CONTROL OF OPEN
HEARTH FURNACES

without obligation. The cost of such welds is low, because of the fact that very little material is used, preheating is saved in most instances, and after-machining is considerably simplified, thus the cost is even lower than for a similar operation done at high temperature.

Another advantage is that welding setbacks are practically unknown. The Eutectic Welding Alloys Company at 40 Worth Street, New York City, who are the exclusive producers and patentees, have developed a line of 42 different alloys which are adapted to weld the following metals — semi-steel, armor plate, cast iron, malleable iron, brass, bronze, copper, nickel and their alloys, aluminum, magnesium, and die castings. In some instances different alloys have been developed for each metal adapted to a particular job. The company's literature explains the difference between the various alloys.

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Vaportight Industrial Lighting CONDULETS
The Adaptable Line
Type C. Obround Series
Type ARC Vaportight Fixture
Type C Obround Condulet with Type ARC Vaportight Fixture
There are Crouse-Hinds Vaportight Lighting Fixtures that can be attached to existing installations of Condulets, for temporary or permanent use.
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Type GSSC Condulet with Type GS Bracket Vaportight Fixture.
Type SK Series Condulets for Use in Concealed Conduit Installations, Particularly in Concrete
Type ARB Vaportight Fixture
Type ARB Bracket Vaportight Fixture
Type SK Condulet with Type ARB Bracket Vaportight Fixture
Outlet Box
Type ARB Vaportight Fixture
Type ARB Bracket Vaportight Fixture
Outlet Box with Type ARB Vaportight Fixture
Type GRF Condulets Have 5 Bosses, Any of Which May Be Drilled and Tapped for Threaded Conduit.
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TO SURVEY STEEL IN BRITISH DOMINIONS

▲ A survey of the steel situation in certain of the British Dominions will be made jointly by representatives of the British iron and steel control and the War Production Board, steel division director H. G. Batcheller announced recently.

Mr. Batcheller, who was requested by British authorities to nominate an American to accompany Sir John Duncanson, controller of the iron and steel control, named Earl A. Emerson, president of the Armco International Corporation, Middletown, Ohio, to represent WPB.

For the purpose of making the survey, which will require visits to India, Australia, New Zealand, and South Africa, Mr. Emerson has accepted a temporary appointment to the War Production Board staff.

The survey is intended to make available to the British iron and steel control and to WPB a study of the steel production, steel consumption, and the deficit requirements of each of the Dominions. Arrangements have been made for Sir John and Mr. Emerson to consult with Lend-Lease, BEW, and State Department representatives in the various Dominions to be visited.

Sir John, one of the best known figures in the British steel industry, has just arrived in this country. The trip to the Dominions is scheduled to begin sometime this month, and will probably last for three or four months.

New Literature

▲ The Askania Regulator Company of Chicago has just published a bulletin which illustrates clearly and describes fully the hydraulic jet pipe principle of automatic control. This folder clarifies the principle, the advantages, and the functions of the jet pipe and is of interest to engineers coping with intricate and critical control problems. A copy may be had by addressing the Askania Regulator Company, Chicago, Illinois.

▲ "Wartime Conservation," a new 96-page booklet just published contains recommendations by Westinghouse engineers for selecting, applying and using electrical equipment so as to achieve the best possible output with the greatest saving in critical materials.

The book covers up-rating of mo-

tors, thermal temperature loading of transformers, industrial network systems, line equipment and materials; and gives tips on saving and salvaging materials as practiced in the various Westinghouse plants.

In addition to pointing out ways of saving vital materials in new equipment purchased, the booklet gives many examples of how existing equipment can be made to give better service and greater output by up-rating or rebuilding with more efficient materials than originally used.

All recommendations in this new book are in line with policies suggested by the WPB for the conservation of critical materials. A copy of booklet B-3206 may be secured from Department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

▲ "Victory Production and Maintenance News," previously issued as "Victory News" by Allis-Chalmers, Milwaukee, Wisconsin, will hereafter endeavor to help industry find out how to keep its production machines running through the rest of the war, the company announces with the release of the new issue.

Inviting an exchange of maintenance ideas from equipment operators, the publication carries these in addition to tips from Allis-Chalmers engineers on the proper maintenance of the hundreds of products manufactured by this company. Emphasis on the value to the war effort of intensifying maintenance is supplemented by production stories in news and pictures, pointing out new ways to increase war production. A handy index lists maintenance articles appearing currently in the leading trade papers.

Maintenance men and executives interested in stepping up maintenance to meet wartime needs in their plants can get this publication regularly by writing the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

▲ Cochrane Bulletin Publication 4009 is now available, descriptive of proportioning equipment of the double displacement type, which eliminates pumps, moving parts, etc., is simple in construction and depends upon the proportioning of one fluid to another by utilization of the pressure loss through the metering element, such as an orifice or Venturi tube.

The proportioning is by displacement in which two tanks are utilized and the chemical solution separated from the water by a layer of thin oil, such as kerosene.

The apparatus is designed for the incorporation of a pH controller, making the apparatus very accurate and sensitive. With this addition the pH value can be maintained in the water treated at a constant value irrespective of the changes in rates of flow and changes in the pH value of the water to be treated.

The apparatus is very readily adapted to the continuous proportioning of acid solutions to feed water, such as sulphuric acid for the reduction of alkalinity and pH value, the addition of coagulants for clarification purposes for the blending or introduction of one fluid to another and can be applied to chemical processes and other industrial requirements, as well as for boiler feed water service.

Complete description with illustrations is given in publication 4009.

▲ The new edition of Leeds and Northrup Company's catalog on Micromax Pneumatic Control stresses the use of this equipment for regulation of pH, conductivity and other conditions, as well as temperature.

This controller manipulates a diaphragm valve in order to maintain the regulation. The valve's opening is greater or smaller, depending on the pressure in its air chamber. In Micromax Control, this air chamber is connected to the control instrument by means of ordinary uncalibrated tubing or small piping. The controller is described as employing a system of electrical and mechanical balances which detects, while they are very small, any departures from the control point, and simultaneously changes the air pressure to correct them.

The publication emphasizes the equipment's ability to re-set itself whenever necessary, so that all the forces which tend to upset the controlled condition can be neutralized — change in load, as well as in fuel or other controlled medium, radiation, weather, etc. The Micromax controller is described as completely factory-assembled, ready to be connected to valve, to thermocouple or other primary element, and to electric power. All control knobs, gauges, etc., are said to be at the instrument, for ready accessibility.

The catalog gives standard ranges, dimensions, shipping weight, etc. A copy will be sent on request to Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania. Ask for Catalog N-00B, "Micromax Pneumatic Control."

▲ Roots-Connersville Blower Corporation, Connersville, Indiana, has just issued Bulletin 120-B-12 covering its centrifugal blowers and exhausters. This is a twenty page booklet in two colors, profusely illustrated, applying to both single and multi-stage units in many sizes.

The foreword includes a brief history of the company's experience in building centrifugal units, together with a list of applications, and goes on with a discussion of the advantages inherent in the centrifugal design. Pages four and five discuss the operating characteristics, with curves to substantiate the statements contained in the text.

Pages six to eleven inclusive are devoted to sectional views, types of impellers, and installation and shop cuts of the various single-stage units which comprise the Roots-Connersville line. Pages twelve to seventeen picture the multi-stage line in equal detail.

One page is devoted to a discussion of various control devices which provide suitable regulation, and another page contains a number of action views of various manufacturing and testing operations.

Although Roots-Connersville is best known as the pioneer builder of rotary positive blowers, its experience in producing equipment for the handling of air and gas, which dates back to 1854, has provided a background of great usefulness in its centrifugal designs.

Copies of Bulletin 120-B-12 may be had by addressing the factory at Connersville, Indiana, or the nearest branch office.

▲ The Herman H. Sticht Company, Inc., of 27 Park Place, New York, New York, has just issued a new bulletin No. 550 describing their new line of slide contact rheostats and fixed tubular resistors with adjustable band. These rheostats contain the new lubricated contact brush which is so superior to old-fashioned non-lubricated brushes.

These rheostats and resistors are of the highest quality and built for long life. The rheostats are single range type, protected or unprotected, and indicating four range types which are quite an innovation in the rheostat field. Besides panel mounting, rotary-drive rheostats can be furnished.

ITEMS OF INTEREST

W. A. Lintern, formerly general manager of the Lintern Corporation has been made president of this organization. A graduate in 1925 of Business Administration, Ohio State University, Mr. Lintern has been associated with the Lintern Corporation and its predecessor since that time, having been secretary-treasurer and general manager. Mr. Lintern is an associate member of the Association of Iron and Steel Engineers.

Edgar N. Yost has been appointed as division superintendent of the new armor plate plant of the Gary Works of the Carnegie-Illinois Steel Corporation, a United States Steel Corporation subsidiary.

Mr. Yost has been associated with the Gary plant since 1916 when he started to work in the inspection department. In 1922, he became associated with the Chicago office of the company, and then in 1936, returned to the Gary plant as assistant chief inspector. He served in this capacity until 1939 when he was promoted to the position of chief inspector, later advancing as head of the armor plate division of the Steel Works.

His assistant in the armor plate division is Thomas J. Griffin. E. C. Vedell is assistant to the division superintendent.

Others appointed in the armor plate supervisory force are: T. H. Sanderson, superintendent of quality control; G. P. McAleer, superintendent of maintenance; P. W. Bennington, division industrial engineer; W. G. Hawley, superintendent of production control; W. G. Stuhlmacher, assistant to division superintendent, fuel; J. E. Clark, assistant to division superintendent, power; G. A. Marks, assistant works auditor; O. B. Canaday, assistant superintendent of plant protection; and A. H. Kofoed, assistant superintendent of industrial relations.

The armor plate plant is the property of the United States Army. It was built at the Army's request with Army funds. The engineering and construction were handled jointly by Army and Carnegie-Illinois Steel Corporation engineers. The plant is leased and operated by Carnegie-Illinois Steel Corporation, as a division of Gary Works. S. M. Jenks as general superintendent of Gary Works also has general supervision over the armor plate division.

Generally recognized as the largest unit of its kind in the nation, the armor plate plant converts slabs through various processes into finished armor plate, ready for welding into tanks. Construction of the plant represents an outstanding wartime job. Carnegie-Illinois Steel Corporation signed the contract officially providing for the plant on April 22, 1942, and in less than six months completed it sufficiently to roll the first armor plate on October 16.

Russell R. Smith, manager of the Ashland, Kentucky, division of the American Rolling Mill Company, retired on April 7, because of ill health. He was succeeded by **Robert S. Gruver,** formerly assistant manager of Armco's fabricating division, in Middletown, Ohio. **R. G. Adair,** assistant manager of Armco's Ashland division has been appointed assistant director of personal relations, with headquarters in Middletown.

Sidney R. Snow has been appointed assistant to vice president of operations of American Steel and Wire Company, subsidiary of the U. S. Steel Corporation. In his new position he will handle operating costs. Born in Ottawa, Illinois, Mr. Snow's first business experience was with the Marseille Company at Moline, Illinois, as clerk in 1910. In 1912 he joined the American Steel and Wire Company at De Kalb, Illinois, as a clerk in the accounting department. In 1916 Mr. Snow was transferred to Cleveland as a bookkeeper. Four years later he enrolled in the Wire Company's student apprentice training class and in August, 1922, was moved to Waukegan as assistant foreman in the galvanizing department. He held various positions at Waukegan until he was made general superintendent of the Waukegan Works in May, 1941.

John R. Gaut has been appointed general superintendent of the Waukegan works of the American Steel and Wire Company.

EDGAR N. YOST

W. A. LINTERN

ROBERT S. GRUVER

Mr. Gaut was born in Greensburg, Pennsylvania, and was graduated from Williams College before starting to work for American Steel and Wire Company in October, 1919, as a steel tracer at the Donora steel works. From March, 1923, to December, 1924, Mr. Gaut was enrolled in the student apprentice course of the company at Cleveland, and was subsequently appointed foreman of the nail specialties and cooperage shop at the Donora wire works. From 1929 to 1939 he worked at North works at Worcester, Massachusetts, before being assigned special duties on the staff of vice president in charge of operations. Mr. Gaut was made assistant general superintendent of the Waukegan works in May, 1941.

Dr. Edgar C. Bain has been appointed vice president in charge of research and technology of the Carnegie-Illinois Steel Corporation. The establishment of this new vice presidency is for the purpose of further intensifying these activities for the company's war effort. Dr. Bain was born near Marion, Ohio, September 14, 1891 and was educated at Ohio State University,

DR. EDGAR C. BAIN

Columbia University and University of Wisconsin. After service in World War I as First Lieutenant in the Chemical Warfare Service, Dr. Bain served successively as metallurgist for General Electric Company, Atlas Steel Corporation, Union Carbide and Carbon Company. He joined the research staff of United States Steel Corporation in 1928, and since 1938 has been assistant to the vice president in charge of research and technology for the United States Steel Corporation of Delaware.

John W. Hacker has been appointed general superintendent of the Christy Park Works, National Tube Company, McKeesport, Pennsylvania, succeeding Walter T. Mahla, who died recently.

Mr. Hacker joined this U. S. Steel Corporation subsidiary in April, 1940 as industrial engineer at the National Works, McKeesport, Pennsylvania, and in March, 1942 became chief industrial engineer of the company with offices in Pittsburgh.

Mr. Hacker is a graduate of the University of Michigan with the degrees of B.S. and M.S. in Engineering. He has had operating experience with the Crucible Steel Company of America and Republic Steel Corporation, and was later associated with Dyer Engineers, Inc.

L. C. Watson has been appointed New England district manager of the Trumbull Electric Manufacturing Company with headquarters at the Plainville factory. In addition to this assignment, he continues as special representative on motor control. Mr. Watson joined the Boston office force in the early part of 1928, after having been a field representative of the Petingil-Andrews Company of Boston, which later became the General Electric Supply Corporation. Associated with him in the operation of the New England territory is Mr. John Ingebretsen, who headed the Boston office since it was opened in the Statler Building in 1928, together with Charles Burt and Robert Booth.

Jay J. Seaver has been elected a vice president of Day and Zimmerman, Inc., engineers, Philadelphia, with branch offices at New York and Chicago.

Mr. Seaver attended the University of Michigan, where he received a degree in mechanical engineering

JAY J. SEAVER

in 1912 and has been associated with the iron and steel industry ever since.

He is a member of the Association of Iron and Steel Engineers.

Daniel Lewis has relinquished active direction of the roll department of the Continental Roll and Steel Foundry Company, but will continue his connection with the company as a consultant. Mr. Lewis' duties have been assumed by William E. Cadman, as manager of roll sales and Arthur E. Murton, as roll manager. Mr. Lewis has been associated with the Continental Company since 1927 and has been active in the industry since his high school days, when he worked in the laboratory of the Lorain Steel Company, Lorain, Ohio. Later he joined the Algoma Steel Company, Sault Ste. Marie, Ontario, Canada, serving as assistant superintendent of the Bessemer department and, subsequently, as superintendent of the rolling mills. In 1910 he joined the Seaman-Sleeth Company (Phoenix Roll Works), Pittsburgh as manager of sales, later becoming plant superintendent. He was with the Wheeling Mold and Foundry Company in 1926 and then joined the Hub-

bard Steel Foundry Company which in 1930 was merged with the Duquesne Steel Foundry Company and the Wheeling Mold and Foundry Company to form the present Continental Roll and Steel Foundry Company.

R. J. Rowen has been appointed manager of the Wheeling, West Virginia, district of the Air Reduction Company. Mr. Rowen was one of the pioneers with Air Reduction, having started in 1916 as a shipping clerk in the distribution department at Philadelphia. He has been assistant sales manager and assistant to the general sales manager in New York. He returned to Wheeling two years ago as assistant manager.

J. R. "Bud" Scott left for service in Uncle Sam's army on April 15th. Truly "one man gang" is about the only way to describe Bud's activities with the Association of Iron and Steel Engineers. His services date back to 1935 when he joined the organization as an errand boy.

Better known as the news photographer for the *Iron and Steel Engineer*, he also supervised and directed the make-up and production on this publication. Through his efforts the magazine achieved the reputation of being an outstanding example of good typography.

J. R. "BUD" SCOTT

Supplementing this, his duties included supervision of the *Iron and Steel Daily News*, which paper was his original conception. He was production and advertising manager of *The Modern Strip Mill*, which publication was issued in 1941. He developed and built up many new advertising accounts for the various publications of the organization and with what time left handled the press relations for the society. He will be missed, but is leaving to participate in a greater cause.

George K. Manning, metallurgist, has been named to the research staff of Battelle Memorial Institute, Columbus, Ohio, and assigned to its division of metallurgical research.

Prior to joining the Battelle staff, Mr. Manning was assistant director of the metallurgical laboratory of the Chicago plant of the Republic Steel Corporation. He is a graduate of Franklin College, Franklin, Indiana, and holds a Master of Science degree in metallurgical engineering from the University of Michigan, where he was at one time a graduate assistant in its Engineering Research Department.

Obituaries

J. H. Barse, electrical engineer for American Steel and Wire Company, Cleveland, Ohio, died March 17th. Born in Little Falls, New York, Mr. Barse was graduated in 1915 from Ohio State University in electrical engineering. After six years as draftsman and appraisal engineer with several concerns, Mr. Barse joined Brown Hoisting Machine Company in 1921. In 1924 he became supervisor of electrical draftsmen at Corrigan-McKinney Company and in 1927 went with American Steel and Wire Company in the position he held until his death. Mr. Barse was a member of the Association of Iron and Steel Engineers since 1931 and served a term as chairman of the Cleveland District Section.

Max W. Babb, chairman of the board of the Allis-Chalmers Manufacturing Company, died March 13th in Milwaukee after an illness of several weeks. Mr. Babb, who had been board chairman since January, 1942 and the company's president for the ten years prior to that, was 68 years old.

He joined the Allis-Chalmers organization in 1904 as the company's attorney. He had practiced law in Iowa with his father after receiving his law degree from the University of Michigan in 1897. He obtained his bachelor of arts degree at Iowa Wesleyan in Mt. Pleasant, where he was born in 1874.

In 1913 Mr. Babb was made vice president and general attorney of Allis-Chalmers, and was closely associated with the late General Otto H. Falk in the management of the concern which underwent tremendous expansion during and after the World War.

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Must have thorough experience in forge plant and machine shop operations, or in engineering departments of steel plants or similar industries. Permanent position with excellent future. Give full facts of experience and education. Address:

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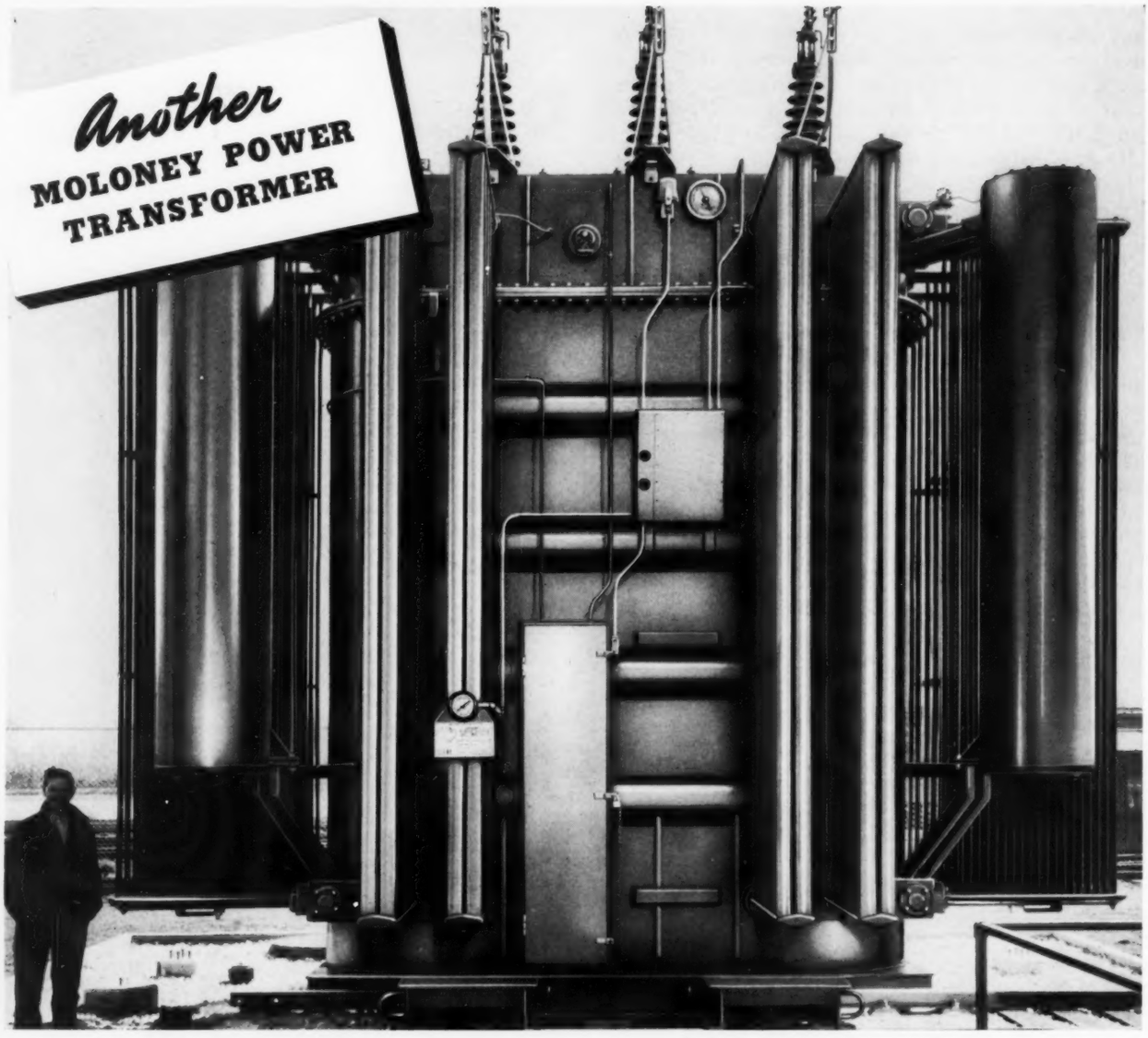


A 25,000 Kva, 69,000 Y to 13,800 volt three-phase transformer equipped with inert gas protection.

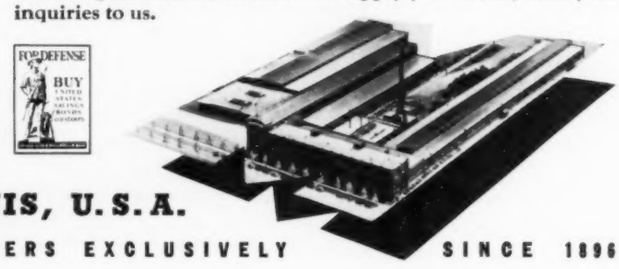
ON THE JOB SUPPLYING *More* POWER FOR AMERICAN PRODUCTION

PICTURED ABOVE is a new Moloney Power Transformer recently installed by a large middlewestern power company to serve vital defense loads. This 25,000 Kva, 69,000 Y to 13,800 volt three-phase transformer is another link for the ever increasing chain of industrial production in the great American cooperative Victory campaign.

Americans today *cannot* afford the loss of an ounce of industrial production energy because of the tremendous responsibility now being borne by the United States. To avoid production losses through power failures, Moloney Transformers are being installed everywhere by utilities and industrial companies with the confidence gained through years of satisfactory, dependable service.

You can depend upon Moloney Transformers because the Moloney Electric Company has been building Power and Distribution transformers exclusively for more than 45 years. The constant research being conducted by our engineers continues in an unceasing effort toward a better product and the maintenance of engineering leadership. Our modern transformer plant, built exclusively for the manufacture of transformers, is equipped with facilities for the production of the largest Power transformers and Distribution transformers as well. Industry standards plus many extra construction and engineering features are incorporated in the manufacture of Moloney Transformers. Skilled workmen, many with a long record of faithful service, greatly help in the achievement of a superior product.

For dependable transformers to supply your needs, send your inquiries to us.



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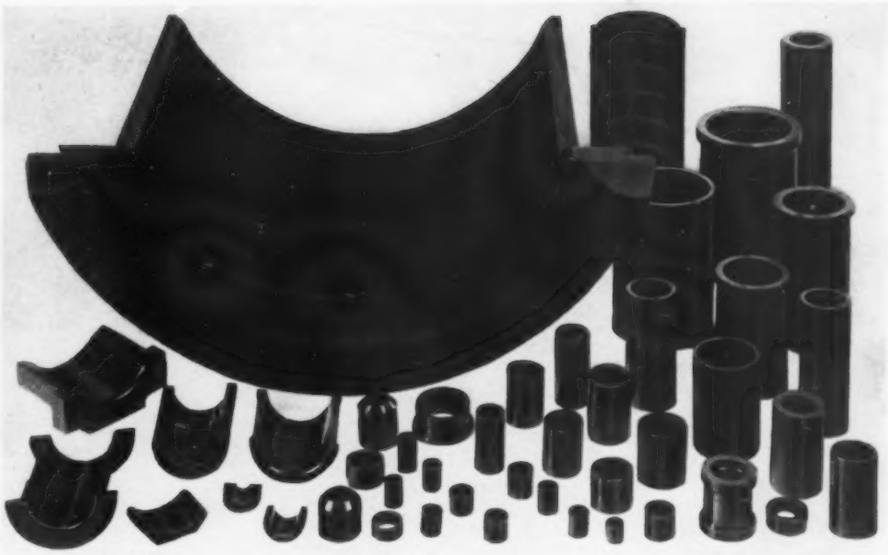

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FOR more than 10 years GATKE Non-Metallic Bearings have been doing the *impossible!* Giving years of service where metal bearing life was measured in weeks. Withstanding shocks too great for metal bearings. Reducing friction tremendously. Avoiding scoring and rapid wear of journals. Saving power. Eliminating 80% of bearing weight. Effecting many other advantages.

Today GATKE Non-Metallic Bearings are conserving critical metals. Their range of successful application is practically unlimited.

The change-over is simple. GATKE Bearings are moulded to machined accuracy in all shapes and sizes for replacing metal bearings without altering bearing holders.

GATKE experience acquired in years of specialization is available in the application of GATKE Bearings to your requirements. Just send dimensional print of bearing and holder with operation data for recommendations.

This catalog describing various applications of GATKE Bearings mailed promptly on request.

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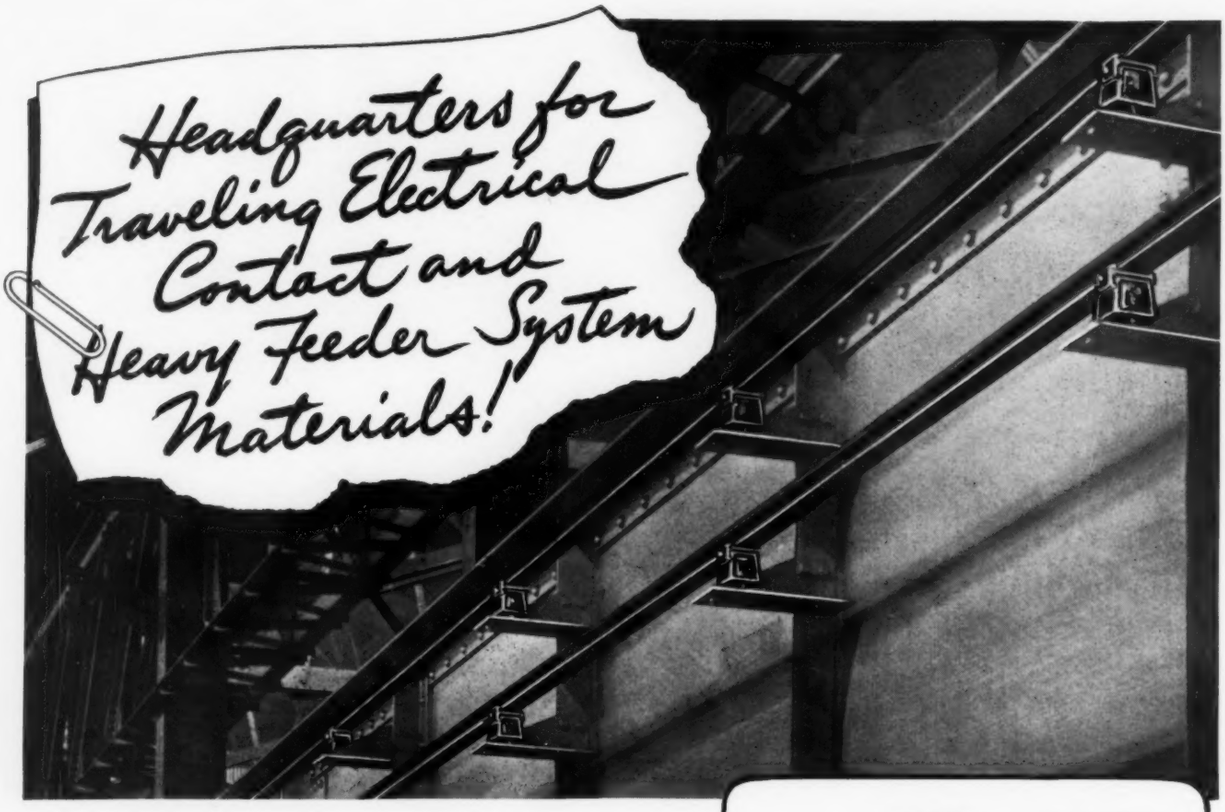
For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.



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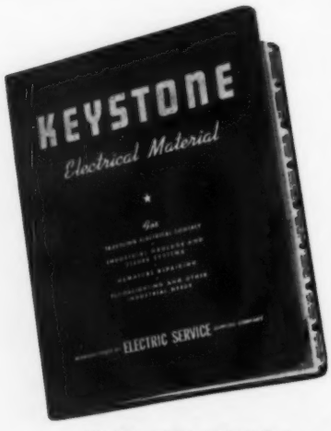
A complete line utilizing either rails, angles or wire as conductors and including numerous types of insulators for either under-running or over-running operation. You may also select from many types of current collectors including Junior, Universal and Pantagraph styles and contact rail shoes.

These products are widely used in most large steel mills, being thoroughly proved in service. The complete catalog illustrated below will be very helpful to all interested in the construction or maintenance of cranes or feeder systems.



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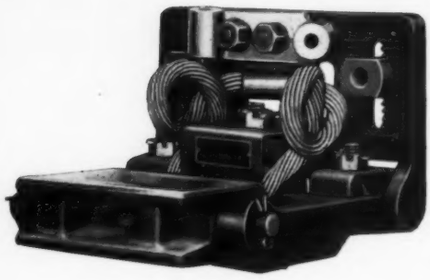
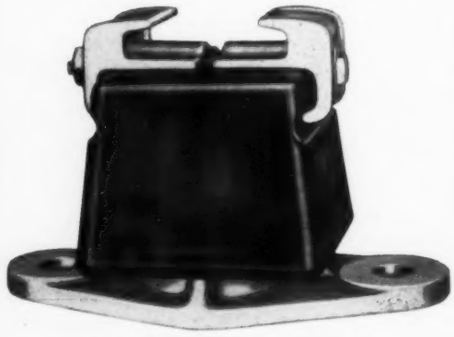


Typical Keystone Reversible Contact Rail Shoe

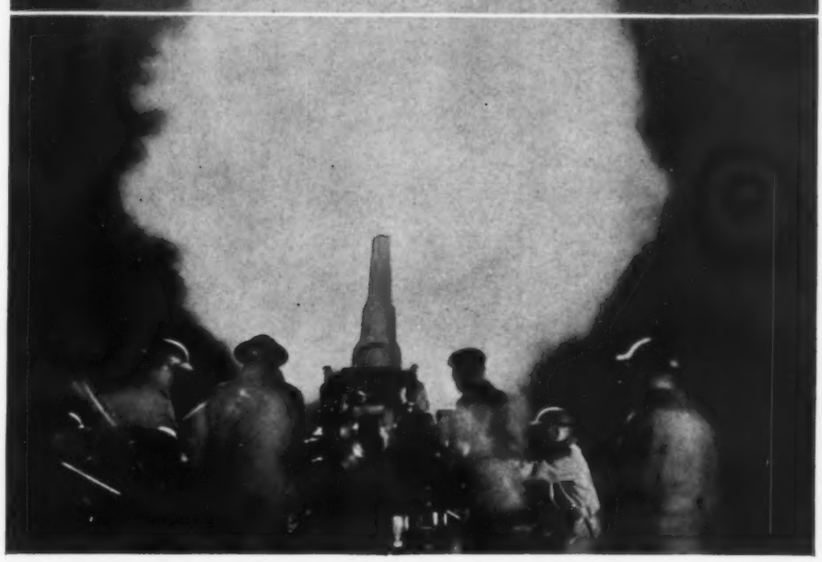


Typical Keystone Contact Rail Insulator for supporting and insulating standard Tee Rail

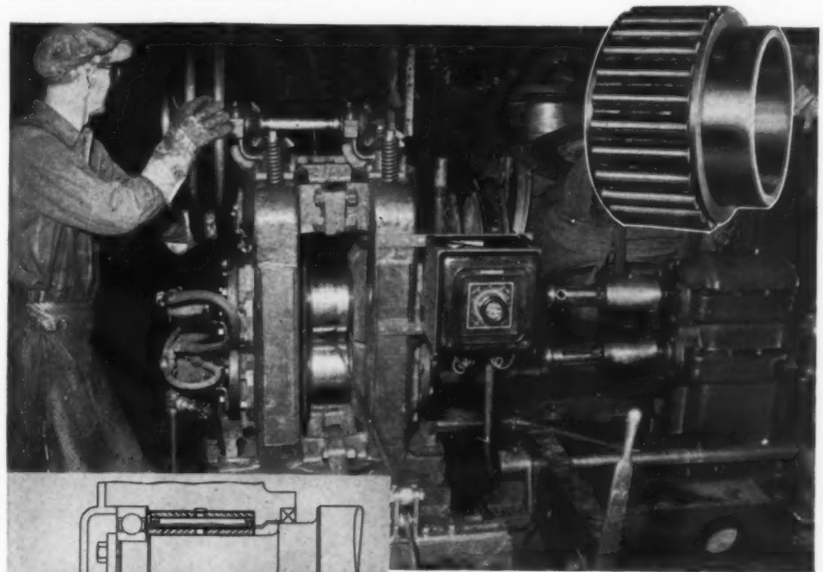
MANUFACTURED BY **ELECTRIC SERVICE** SUPPLIES COMPANY

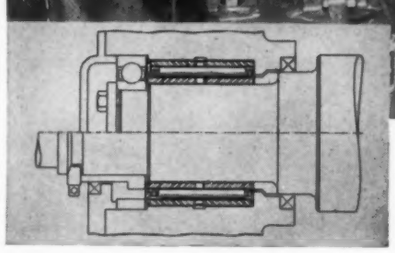
17th & CAMBRIA STREETS • PHILADELPHIA • PA. • BRANCHES IN PRINCIPAL CITIES AND FOREIGN COUNTRIES

IN THE NEWS
WITH BANTAM BEARINGS

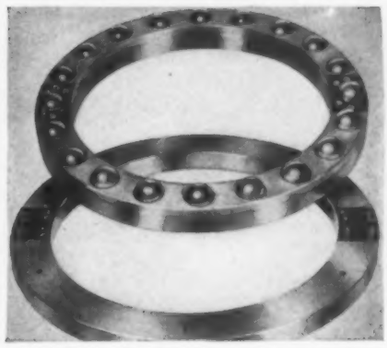


THE TARGET IS MILES ABOVE—yet these 3-inch anti-aircraft guns find their mark with deadly accuracy. The design of America's war equipment—and of the machines to produce it—presents new challenges to industry—and Bantam's skill in the design of special bearings is of great assistance in meeting these new tasks. To serve America's war needs, Bantam has built some of the largest anti-friction bearings ever constructed.

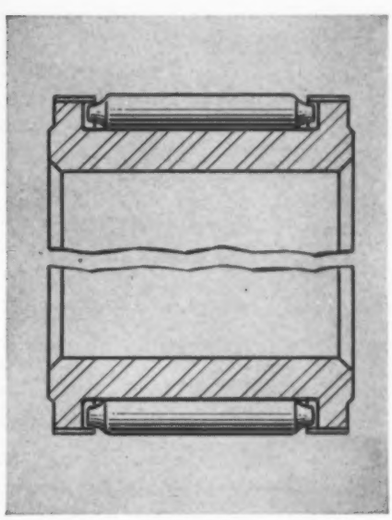




HIGH CAPACITY in a small space is provided by Bantam straight radial roller bearings in this 8-inch flattening mill built by Broden Construction Company, while Bantam Ball Bearings take the thrust load. The bearing arrangement, shown in cross-section view, permits compact design and ease of assembly.



SPLIT-RACE BEARINGS like this one, of the ball thrust type, 19½" I.D., 25" O.D., 3¾" thick, frequently facilitate the assembly of machines. This is typical of the many types of out-of-the-ordinary bearings that Bantam has produced for unusual requirements. Split-race bearings have also been designed and manufactured by Bantam in roller thrust and radial types.



MODIFIED QUILL BEARINGS are adaptable to special applications—retain the familiar advantages of the standard type. In the bearing shown, the rolls are retained to the inner race instead of the outer, as in the standard Quill Bearing. This construction is useful for cases where it is difficult to assemble the parts when the rollers are retained by the outer race.

BANTAM'S ENGINEERING EXPERIENCE covers the design and application of every major type of *standard* anti-friction bearing, as well as of a wide variety of special sizes and types. For advice on the selection of bearings that meet *your* requirements, TURN TO BANTAM.

ARMY E NAVY

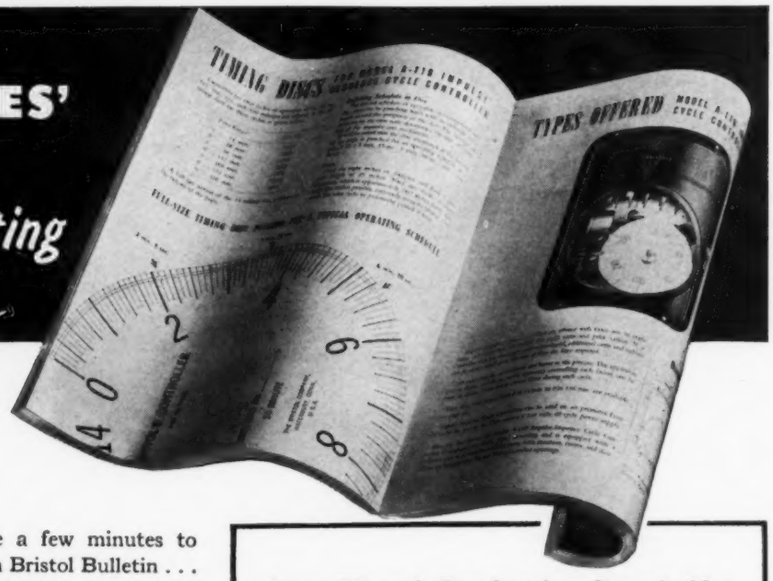
BANTAM BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION · SOUTH BEND · INDIANA

SUBSIDIARY OF THE TORRINGTON COMPANY · TORRINGTON, CONN.

YOUR 5 MINUTES' READING
May Help His Fighting



When you take a few minutes to glance through a Bristol Bulletin . . . then write for further facts about Bristol's instrument-engineering in *your* industry . . . you may be taking the first step towards solution of one or more of the fundamental problems facing your plant today. Such problems as these, for instance, have often been solved by a wider, more efficient use of Bristol's automatic controls:—*1. Lack of skilled men . . . 2. Shortage of raw materials . . . 3. Need to increase output without increasing space or equipment. . . . 4. Unnecessary spoilage and rejects . . . 5. Errors in putting new products into production.*

Bulletin 572 — Typical of Bristol's Clear, Up-to-Date, Factual Information on Automatic Control of Mechanical Operations in Industrial Processes

Automatic timing of mechanical operations in industrial processes received its initial impetus when the Bristol Automatic Time-Cycle Controller was developed. Continuous improvements have been made through the years.

Here, in one concise 20-page bulletin, is a complete outline of this "template for efficient operation" — the mechanical operations you can control with it — the results in terms of quality, cost and increased production — details on its operation — and case studies illustrating its application to a wide variety of processes.

Bulletin 572 may point *your* way to a greater production efficiency than you have hitherto imagined possible. Write for it, together with any other bulletins described in the coupon.

THE BRISTOL COMPANY, Waterbury, Connecticut

The Bristol Co. of Canada, Ltd. Toronto, Ontario

Bristol's Instrument Co. Ltd. London, N.W. 10, England

BRISTOL ... *Gives YOU the Most from Heat*

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

Open Hearth Production Speeded by Bristol's Cycle Control of Furnace Reversals

Control of checker temperatures, and their coordination with furnace reversals formerly consumed a valuable man's time and was apt to delay production through error. Complete automatic reversal of the furnace is now accomplished by Bristol's Cycle Controller governed by a checker-temperature controller, freeing manpower to increase production elsewhere, and insuring a larger, because more uniform, output.

FREE Bulletins from Bristol's Library of Engineering Data — One of Them May Help You Increase Wartime Production

THE BRISTOL COMPANY
123 Bristol Road, Waterbury, Connecticut

☐ Please send me Bulletin 572, described above. In addition send me any of the Bulletins checked below.

☐ Bristol's complete manual of instruments for industrial furnaces, kilns and ovens. The most necessary instruments — pyrometers, thermometer controllers, draft controllers, thermocouples, control valves, and many accessories — described with installation and performance facts for all types of fuel.

☐ Bulletin 536 — Describes modern pH control instruments for a wide variety of processes requiring hydrogen ion measurement and automatic control; includes installation data, new glass electrode assembly and list of applications.

☐ Bulletin P 1102 — Complete facts on Bristol's Radiation Pyrometer for recording and automatically controlling temperatures above 900° F. Describes typical installation, scales charts; summarizes advantages of temperature-sighting without contact with work.

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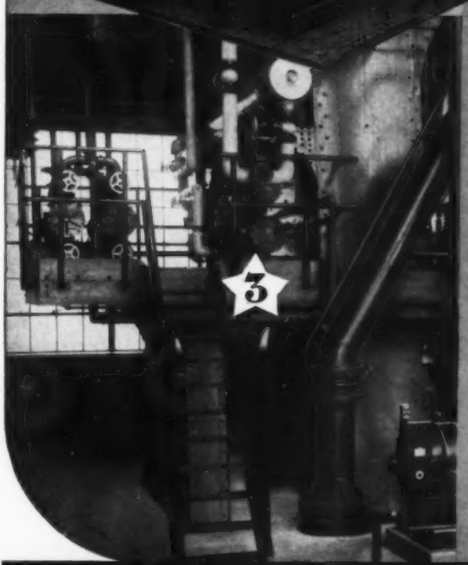
To Avoid Fire Hazard

ISOLATE OIL FROM HIGH-TEMPERATURE STEAM

De Laval turbine driving 4000 kw alternator (5000 kw maximum)



IN this De Laval multistage turbine power is transmitted mechanically to the valve-lifting gear 1 at the top of the casing from a pilot-controlled hydraulic cylinder in the sub-base, 2 which also encloses the speed governor, accumulator and relief valve, and other parts relating to the governor control.

The main reservoir for both lubricating and hydraulic pressure oil, the main and auxiliary oil pumps, the strainers, and the oil coolers are located on a platform 3 below the sub-base.

No oil cylinders or oil piping are over the steam chest or the steam piping, thus keeping oil away from high-temperature steam.

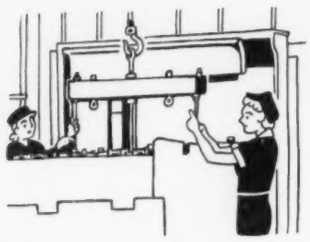
Other requirements of high-pressure, high-temperature steam have been met by the use of special alloys and improved design throughout.

Ask for Publication T-3527

DE LAVAL Steam Turbine Co.

TRENTON, N. J.

MANUFACTURERS OF TURBINES · STEAM HYDRAULIC PUMPS · CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT MOTOR-MOUNTED MIXED-FLOW CLOGLESS SELF-PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS · GEARS · WORM, HELICAL and FLEXIBLE COUPLINGS



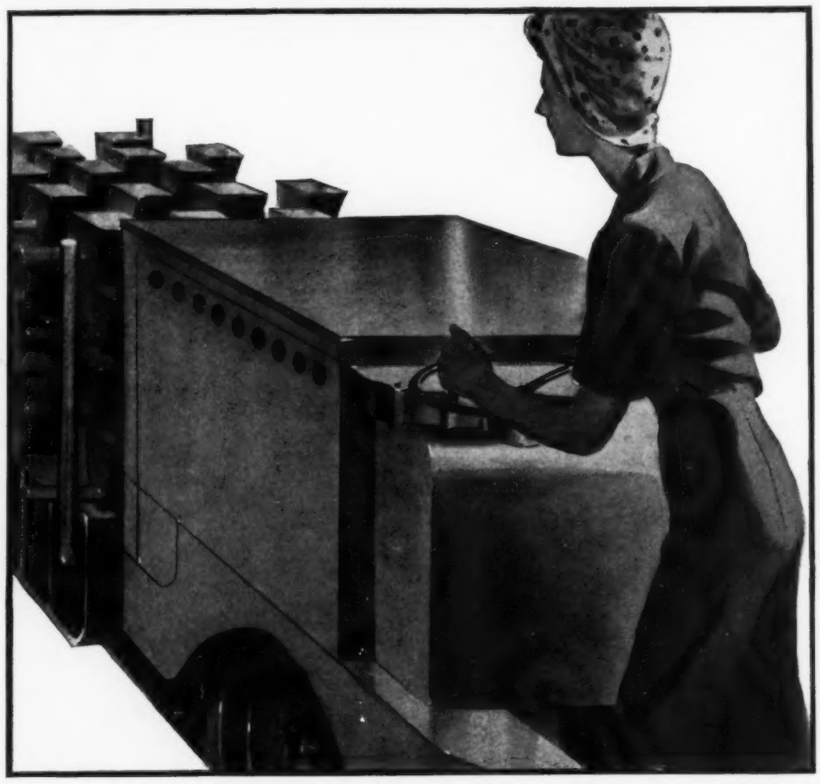
Girls Can Do It. Can women operate battery industrial trucks? Can they charge and exchange the batteries? Do they make good operators? The February issue of Storage Battery Power contains an article describing the experience of one plant with women truck operators. If you have not received a copy, ask for one.

24 Truck Hours Daily. Using three 8-hour batteries or, preferably two 12-hour batteries and exchanging them at corresponding intervals gives you a truck that will operate 24-hours a day with no truck time out for charging or watering of batteries. That's done while the batteries are out of the truck. And alkaline batteries are easy to exchange because of their light weight.

Road-Time. Railroads have no more freight cars in number than during the last war, but are getting double the use out of them. *Quicker loading* and *unloading* and *fuller loads* thanks to lift and fork trucks which permit pallet and skid shipping are part of the reason. More freight cars would be on the road more time if identical pallet and skid systems were in use. Consignor and consignee can get together to standardize shipping procedure—save money for themselves—and help the war effort.

Edison Storage Battery Division
Thomas A. Edison, Inc.
WEST ORANGE, N. J.

POWER TO CARRY ON



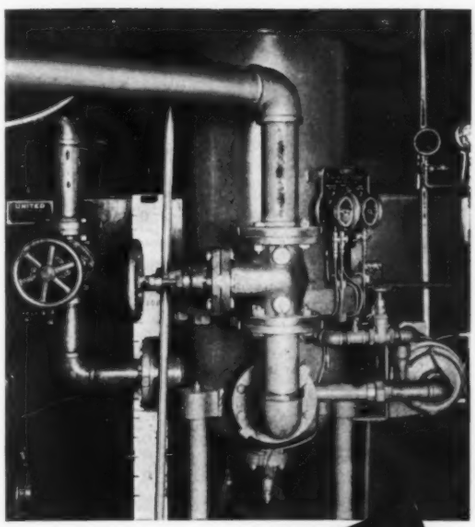
"It's the power unit best suited to the war production job." Here you have the answer to the preference for material handling trucks equipped with alkaline batteries. First, *fewer* trucks can do *more* work where storage batteries provide the motive power. There's no time off duty for repairs, "spare" trucks don't have to be on hand for emergencies and each truck can operate 24 hours out of 24. Second, you can use a battery truck *anywhere*—in freight cars, elevators—it can even be made explosion-proof.

And, the advantages of alkaline batteries in such trucks are quite clear. They can be charged in 6 to 7 hours and require no periodic equalizing charges, thus permitting maximum use of charging circuits. Where d-c shop lines are available they can be charged direct from the lines by the use of control panels only. But most important of all, alkaline batteries are dependable—they are not subject to unexpected sudden failure.

INDUSTRY NEEDS THE DEPENDABILITY OF

Edison Alkaline BATTERIES

Cuno Keeps Coolant Continuously Clean at Follansbee



Roll body coolant at Follansbee is kept continuously free from foreign solids by the Cuno Flo-Klean Filter, shown in the photograph at left.

Straining a coolant solution 94% water and 6% soluble mineral oil, this Cuno Flo-Klean is built to .006-inch spacing with free area of 75 sq. in. and has a capacity of 231 g.p.m. at a 3-lb. pressure drop, or of 347 g.p.m. at a 4-lb. pressure drop. Small steel particles and other dangerous suspended solids are separated from the coolant by this filter and removed from the system.

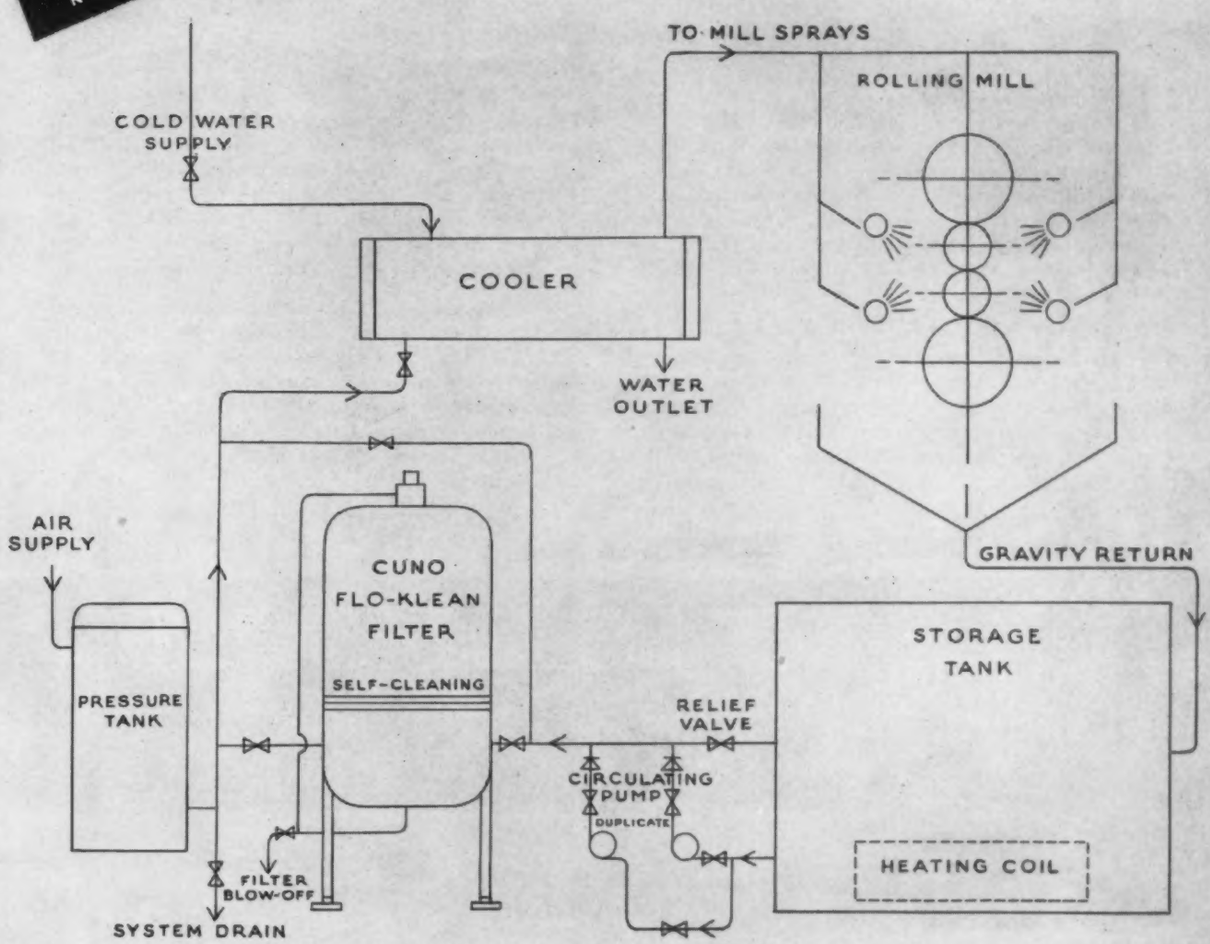
Gives Water a Bath — Then Cleans Itself. The Cuno Flo-Klean is a backwash type of filter, with filter element consisting of one or more wire-wound cylindrical cages. Fluid flows through slots between wires — all solids larger than slots are retained on outer surface. Backwash fluid, picked up at the outlet connection by a small booster pump and delivered to a slowly rotating nozzle, causes momentary reversal of flow at each section of the filter element, and thus dislodges adherent solids. No loss of fluid since all backwash is returned to the system. Accumulated solids are periodically drained through manually or mechanically operated blow-off valve; and floating sludge is simultaneously removed through a top blow-down.

Ends 3 Dangers to Peak Production. Cuno Flo-Klean filters prevent shutdown of fluid flow for filter-cleaning, especially where costly and space-consuming duplex installations are impractical. They provide a high degree of filtration, prevent abrasive particles from getting into the system to cause expensive damage or delays. And they do not need to be disassembled for cleaning —consequently do not expose the system to contamination during this operation.

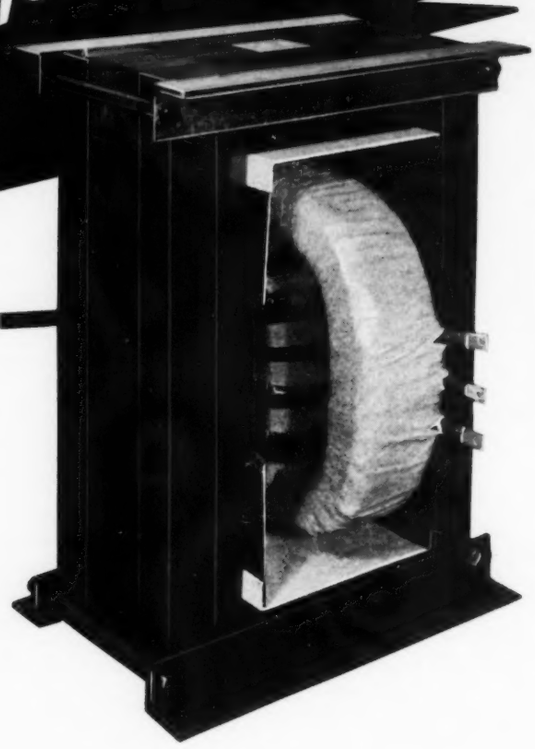
Two Types of Cuno Filters Available. Cuno Auto-Kleans (disc-type) operate on edge filtration principle, handle full flow and are continuously cleanable (manually or automatically); for fuel and lube systems, as well as other industrial liquids.

Cuno Flo-Kleans (wire-wound) are designed especially for fluids of high abrasive content, i.e. descaling spray and roll body coolant systems.

For descriptions of newsworthy applications, write for free booklet, "Quick Facts". Cuno Engineering Corporation, 904 South Vine St., Meriden, Conn.



INSULATED FOR 30,000 VOLTS
- AIR-COOLED -



Synthite* PX-5

Insulating Transformers like the 8.3 KVA air cooled unit partly completed above provide isolation of circuits having a potential difference of 30,000 volts. This certainly is of interest. To insure non-failing insulation, the manufacturers, Nothelfer Winding Laboratories of Trenton, New Jersey, specified DOLPH'S SYNTHITE PX-5 Black Baking Varnish for impregnation of all their windings.

SYNTHITE PX-5 Black Baking Varnish cures by heat induced chemical polymerization leaving no trapped solvents or uncured varnish even in the deepest interstices of large coils. Possessing high dielectric strength and excellent bonding properties, it is ideally suited for use on the newer types of magnet wires and with Class B insulation. This grade also affords maximum resistance to moisture, acids and alkalies and can withstand high temperature rise. Then too, it will not fracture when the temperature drops lower than — 40° F. SYNTHITE PX-5 Black Baking Varnish will bake out with the use of near infra-red equipment or the conventional baking oven.

In ever increasing numbers, manufacturers of all types of electrical equipment are turning to SYNTHITE PX-5 Black Baking Varnish as the logical solution to the many problems of varnish insulation presented by the high speed and high voltage equipment of today. Further information will gladly be sent upon request.

*Reg U. S. Pat. Off.

Dolph's

JOHN C. DOLPH COMPANY

Insulating Varnish Specialists

166A EMMETT ST. NEWARK, N. J.

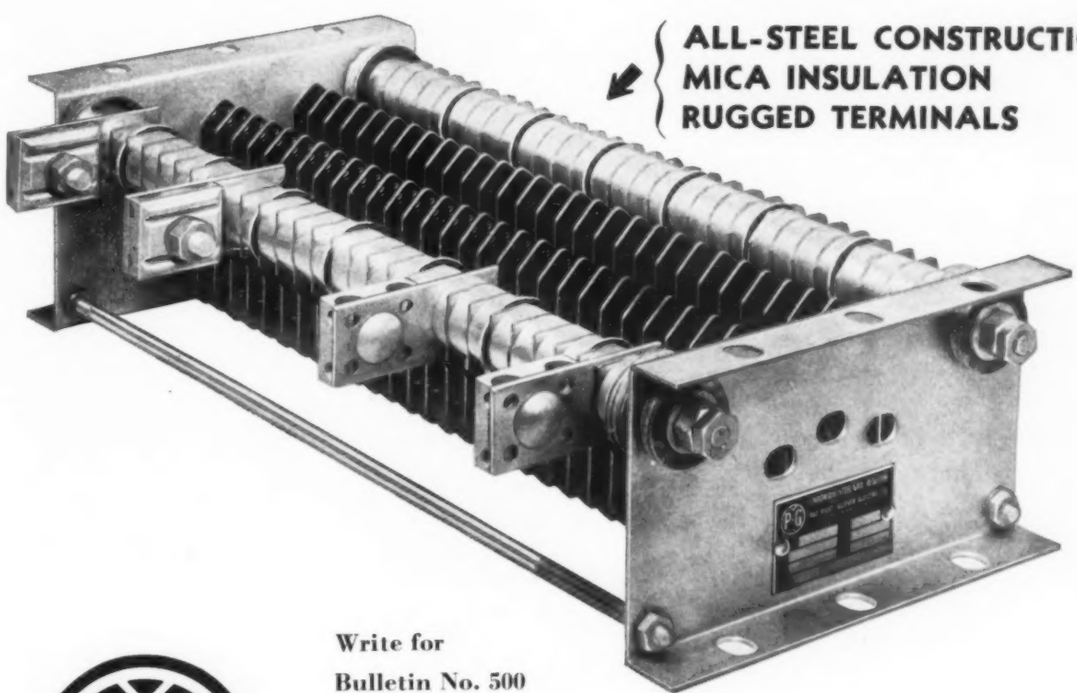
P-G *Steel Grid* RESISTORS MEASURE UP

...TO EVERY REQUIREMENT FOR CONSTANT, "TROUBLE-FREE" RESISTOR SERVICE

Resistors must stand up under a variety of adverse conditions to "deliver the goods" in steel production. P-G Steel Grid Resistors are especially built for this particular service.

Designed with adequate ventilation and provision for expansion, they are not affected by vibration, moisture or corrosive fumes. Steel Mills favor P-G "Non-Breakable" Resistors for heavy duty service because of

ALL-STEEL CONSTRUCTION
MICA INSULATION
RUGGED TERMINALS



Write for
Bulletin No. 500

"The Resistor you can Install and Forget"

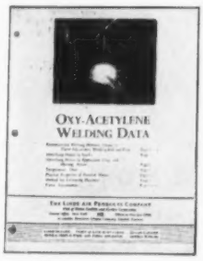
THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO

HELPFUL LITERATURE
for Oxy-Acetylene Welding and Cutting Operators

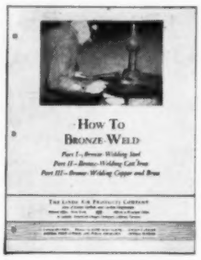
As part of our service to industry, the Linde organization makes available a library of oxy-acetylene process information. A partial list of this "how-to-do-it" literature is shown here. If you need copies of any of the booklets described, you can obtain them from any Linde office, without charge. Please ask for them by Form numbers.



OXY-ACETYLENE WELDING DATA

12 pages—Form 4600

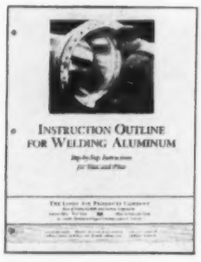
Charts, tables, and recommended welding methods; choice of flame adjustments, welding rod, and flux; methods for identifying metals; physical properties of familiar metals; temperature data chart; and a conversion table for hardness numbers are included in this booklet.



HOW TO BRONZE-WELD

16 pages—Form 4328

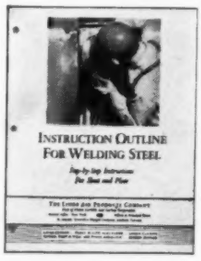
This booklet discusses the theory and advantages of bronze-welding, and describes by means of step-by-step pictures correct techniques for bronze-welding steel, cast iron, copper and brass. Bronze-welding and bronze-surfacing techniques are also shown in pictures of practical applications.



INSTRUCTION OUTLINE FOR WELDING ALUMINUM

8 pages—Form 4538

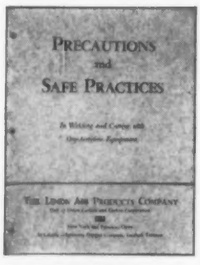
Instructions for welding aluminum sheet and plate, including the choice of proper flame and rod, the joint design, the use of jigs and supports, and cleaning and fluxing, are given in step-by-step illustrations. How the physical characteristics of aluminum affect welding technique is also discussed.



INSTRUCTION OUTLINE FOR WELDING STEEL

20 pages—Form 4645

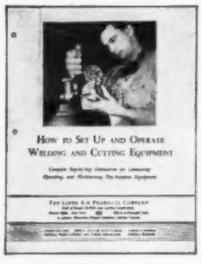
This is a series of practice exercises ranging from primary melting to making position butt welds in steel sheet and plate. Instructions for blowpipe manipulation and rod deposit, and examples of both good and poor welds, are included for guidance in correcting faulty procedure.



PRECAUTIONS AND SAFE PRACTICES

56 pages—Form 2035

A copy of this booklet should be in the hands of every operator of oxy-acetylene welding and cutting equipment. It completely covers all the safety precautions that should be observed in setting up and operating equipment, in handling calcium carbide and oxygen and acetylene cylinders, and in maintaining equipment.



HOW TO SET UP AND OPERATE WELDING AND CUTTING EQUIPMENT

20 pages—Form 5165

Complete, step-by-step illustrated instructions for connecting, operating, and maintaining oxy-acetylene welding and cutting equipment. A careful study of the various suggestions in this booklet will aid all operators in getting the most out of their equipment, and will help to promote safety.

OXY-ACETYLENE HEATING FOR BENDING, STRAIGHTENING, AND FORMING

8 pages—Form 4200

The many applications of the oxy-acetylene flame for "smithing" operations, its use in automotive production and repair, in the boiler shop, and for upsetting and stretching, are reviewed. Three methods for straightening bent shafts are given.

STEEL HARD-FACING PROCEDURE

8 pages—Form 3491

The special instructions given here, based on the general hard-facing procedures, should prove helpful to everyone applying Haynes Stellite alloy to steel surfaces. A chart of hard-facing materials data and a listing of suggested hard-facing applications are also included.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

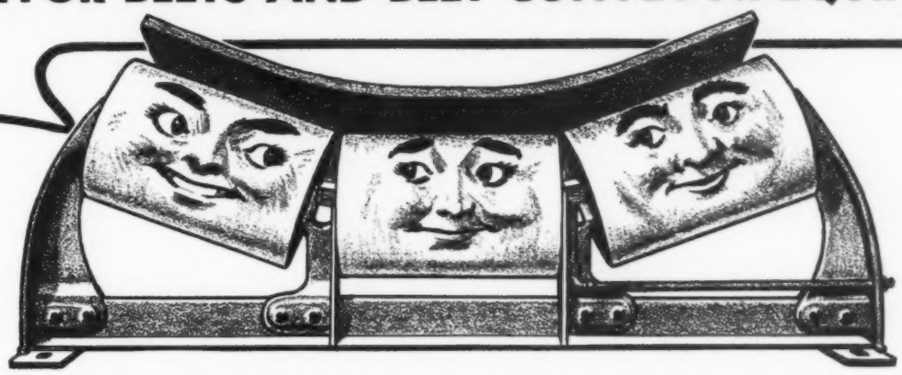
30 E. 42nd St., New York, N. Y. UCC Offices in Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

The words "Haynes Stellite," "Oxweld," "Linde," "Prest-O-Lite," "Union," "Prest-O-Weld," and "Purox" are trade-marks

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

BROTHER, BE WISE—PROLONG THE LIFE OF CONVEYOR BELTS AND BELT CONVEYOR EQUIPMENT!



If "we" could only talk—here's what we'd say: "Operators, please give us extra special care to make us last longer. This is mighty important during wartime, because materials used in belt conveyor equipment are needed for guns, tanks, planes and other war equipment. Be wise—be patriotic—follow this advice—it will pay extra dividends in trouble-free operation."

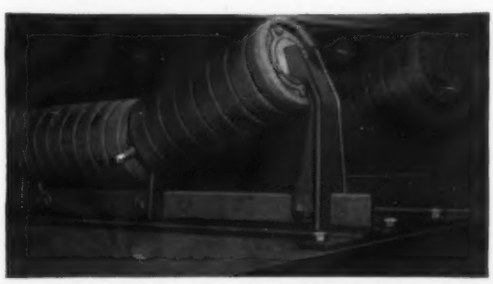
1

KEEP INSTALLATION CLEAN. Cleanliness plays an important part in prolonging the life of your belt conveyor equipment. Make a daily inspection to see that there is no accumulation of material that has spilled off the belt. If material is not removed it will cause the belt to drag over it as well as around the head, tail, snub and other pulleys. Consideration should also be given to cleaning the belt. The material being handled determines the type of cleaning device.

2

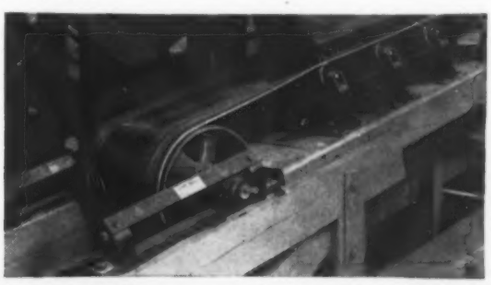
TRAIN THE BELT AND MAINTAIN THE TRAINING WITH SELF-ALIGNING IDLERS. It is important that both the carrying and return runs of a conveyor belt be kept practically central with its supporting idlers. This can be accomplished by properly "training" the belt on the conveyor . . maintaining that training is assured through the use of self-aligning idlers and return rolls. Link-Belt manufactures a complete line of self-aligning idlers to meet every need.

3



USE IMPACT IDLERS AT LOADING AND TRANSFER POINTS. When tons of ore, rock, coal and other materials slap a belt on the back, proper protection must be given at the loading point. The use of Link-Belt Rubber-Tread Impact Idlers definitely prolongs belt life by preventing cutting and bruising of belt . . cushioning even the heaviest blows . . thus greatly increasing belt life and protecting the belt, idler bearings and framework. Link-Belt engineers will be glad to make recommendations.

4



MAINTAIN PROPER BELT TENSION AND LUBRICATION. Eliminate excessive belt sag between idler rolls—Proper tension relieves the belt of much unnecessary wear . . Never over-lubricate idler rolls—inspection of one idler roll will often determine at what intervals equipment should be lubricated. Too much grease is as bad as too little.

AND MAKE IT A RULE to establish regular inspection periods—and make replacements with genuine Link-Belt parts when necessary. Link-Belt manufactures a complete line of idlers, pulleys, bearings, take-ups, drives, trippers, etc.

LINK-BELT
BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY
Indianapolis, Chicago, Philadelhia, Atlanta, Dallas, San Francisco, New York, Toronto, Pittsburgh, Cleveland, Detroit. Offices, warehouses and distributors in principal cities. 9067C

REDUCE BEARING FAILURES

Equip war production machines with

LINCOLN CENTRO-MATIC LUBRICATING EQUIPMENT

Make it impossible to overlook the lubrication of a bearing whose failure might cause a shut-down. How? By installing a Centro-Matic System. Then every bearing can be safely and surely lubricated in a fraction of former time—without stopping machines.

Illustration above shows manually operated Lincoln Centro-Matic Lubricating System installed on a big punch press.

A Centro-Matic System consists of a number of Centro-Matic Injectors—one for each bearing—and a power operated or a hand operated Centro-Matic Lubricant Pump. A power operated system can be semi-automatic or fully automatic . . . The injectors can be grouped in manifold or located separately at each bearing. In either arrangement only a single lubricant supply line is required . . . Easily installed on new or old machines.

Write us today for complete information 143-9

ARMY E NAVY

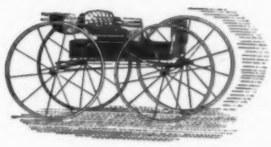
ARMY-NAVY PRODUCTION AWARD for high achievement in the production of war equipment has been conferred upon the Lincoln Engineering Company. It serves as inspiration toward greater and greater accomplishment until the time of final and complete Victory.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

ST. LOUIS, MO., U. S. A.



1853

1898

90 YEARS

OF FAITH

in the American System

IN 1853 a young man, believing in the sound principles of the American Free Enterprise System, started making wagons and carriages. Adhering to these principles, his business grew. He incorporated in 1888.

With unlimited faith in the American System, this growing Cleveland Company began the manufacture of electric vehicles in 1898. In 1901, the Baker Electric Torpedo startled the world with a record speed of 104 miles per hour. This same year, Baker built the first shaft-drive automobile. In 1911 Baker contributed the worm-gear drive. In 1917, foreseeing our great industrial development, Baker went into the business of making industrial power trucks. Thousands of these trucks are today speeding production and the handling of material all over the world. A second Baker plant builds commercial truck bodies to meet the specific requirements of public utilities.

Today we are at war. Along with other American industries, The Baker-Raulang Company has enlisted for the duration. Both plants are engaged 100% in war production. At the same time we are looking forward to playing our part in the rebuilding of peacetime industry, as we have done three times before in our history.

After 90 years—during which we survived more than a dozen major depressions, we still have faith in the System of Free Enterprise which has built the world's greatest nation—a nation capable of saving the world from despotism, through industry. We trust in the common sense of the American Public to justify our 90 years of faith—to keep America free for the rebuilding job in the critical years ahead.

1943

THE BAKER-RAULANG COMPANY

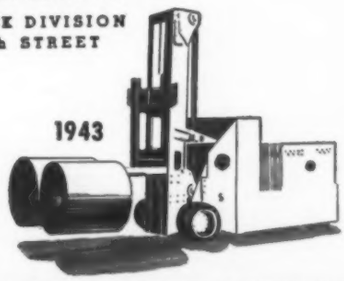
UTILITY BODY DIVISION
1280 WEST 80th STREET

★

INDUSTRIAL TRUCK DIVISION
2168 WEST 25th STREET

CLEVELAND, OHIO

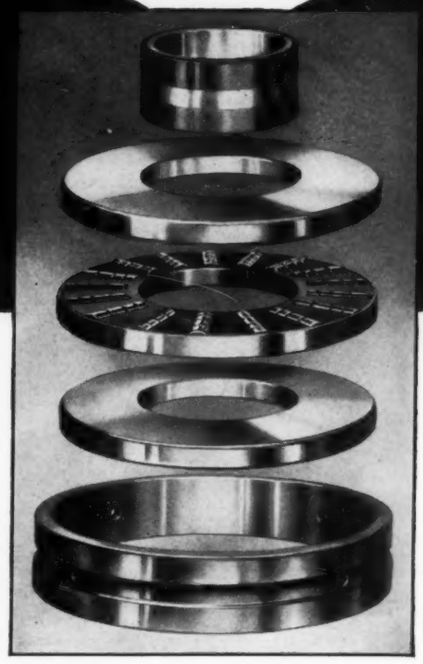
UTILITY BODIES
Baker
INDUSTRIAL TRUCKS



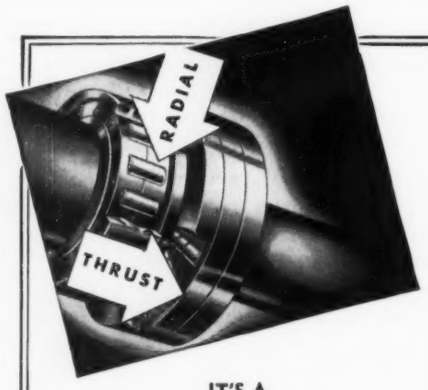
1943

For Longer Thrust-Bearing Life USE ROLLWAY'S *Right Angled Loading*

All loads carried at right angles to the axis on short and staggered solid-cylindrical rollers.
NO
OBLIQUE RESULTANTS
on rollers.



THE right-angle-loading rule for roller bearings is safer to follow because it's simpler. It splits complex loads so that the two fundamental components of pure radial and pure thrust are each carried at right angles to the roller axis. NO OBLIQUE RESULTANTS tend to squeeze the rollers from between the races. Thus, in thrust bearings, rubbing contact between the roller ends and the retainer is held to a minimum. In radial bearings, there is less wear-back on the radius of the races. Friction is reduced; bearing capacity increased. You don't have to depend upon maintained oil-film for low-torque starts. The net result is smoother running, longer life, reduced service cost, and less down-time due to bearings.



IT'S A BASIC PRINCIPLE WITH ROLLWAY

- All radial loads carried at right angles to the roller axis.
- All thrust loads carried at right angles to the roller axis.

ALL ROLLWAY ROLLER BEARINGS ARE LOADED THE RIGHT-ANGLED WAY

One of the pioneer American manufacturers in the design and application of roller bearings to heavy industrial uses, Rollway has consistently specialized in the right-angled loading of solid-cylindrical roller bearings. That's because 35 years of experience has proved that no short-cut or compromise provides the same effectiveness and lasting qualities as these bearings in *pure radial and pure thrust types.*

SAE and AMERICAN STANDARD METRIC SIZES

Rollway has developed many variations of its solid-cylindrical roller bearings in SAE and American Standard metric sizes, each having definite characteristics to meet exacting needs. Take full advantage of this wide choice of types and sizes, and of Rollway's specialized bearing experience. Just send us your design, or ask for free, confidential bearing analysis and recommendation.

ROLLWAY BEARING COMPANY, INC., SYRACUSE, NEW YORK

BUILDING HEAVY-DUTY BEARINGS SINCE 1908 **BEARINGS**

Wagner MOTORS

reflect sound engineering and modern manufacturing methods

The skill and facilities Wagner has gained in 52 years of manufacturing quality electric motors are now being used to speed up Victory.

Wagner motors are built in a wide range of types and sizes with electrical and mechanical characteristics varied to meet the motor-drive requirements of all auxiliary equipment used in the steel industry.

If you need motors to help speed up war production, consult the nearest Wagner branch office.

M43-9A

FIELD ENGINEERING SERVICE

PITTSBURGH, CHICAGO, NEW YORK and all the rest of Wagner's 29 branches are manned by trained field engineers competent to solve your motor application problems.

Wagner Electric Corporation

ESTABLISHED 1891

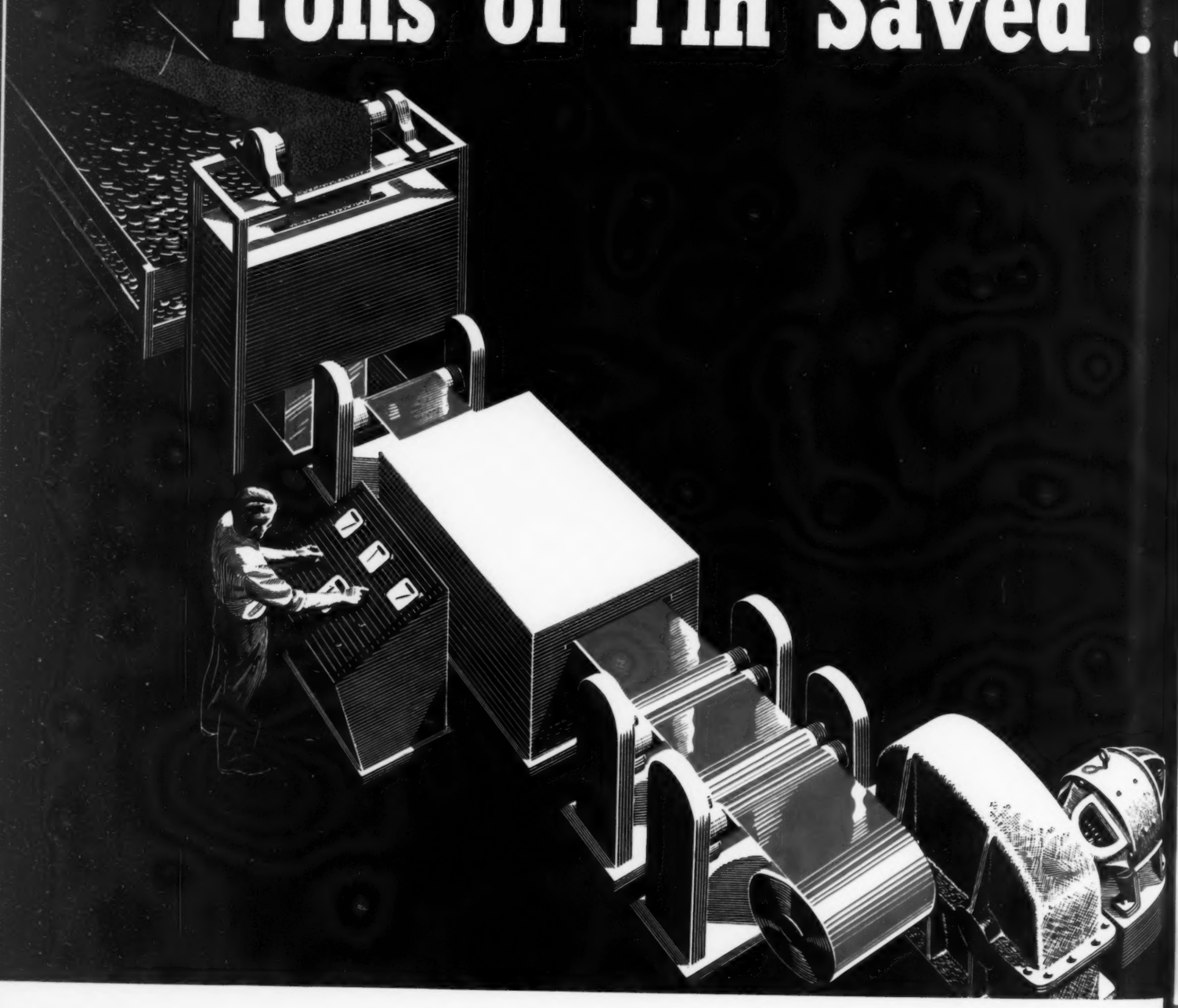
6400 Plymouth Avenue, St. Louis, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

SEND FOR COMPLETE LITERATURE

Bulletin MU-182 describes and illustrates the complete line of Wagner totally-enclosed fan-cooled motors, the ideal motors for all motor-driven equipment used in the steel industry. Write for your copy today.

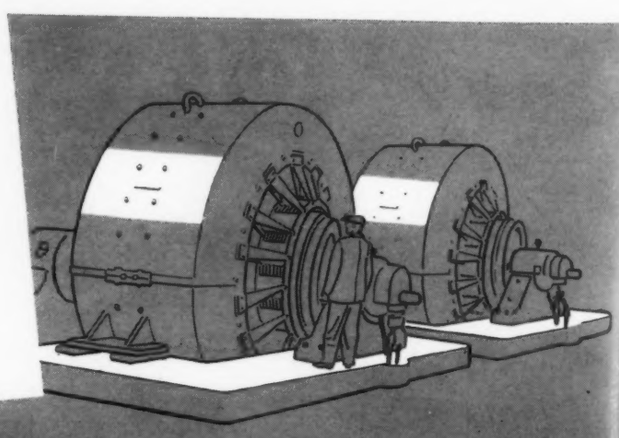
Tons of Tin Saved . . .



SAFEGUARD MAIN-DRIVE MOTORS

Precipitron—Westinghouse electric air cleaner, provides continuity insurance for main-drive motors and MG sets. By removing all air-borne dirt, dust and soot—including particles as small as 1/250,000 of an inch—this electronic device prevents damaging dirt from settling in windings. Result: increased operating efficiency, with fewer shut-downs for repairs. Write for Booklet B-8605.

Westinghouse



. . BY INDUCTION HEATING

"FLOW" PROCESS

For years, most of America's tinplate was made by the "hot dip" process. This took 1½ pounds of tin for every 100 pounds of steel . . . not too much when tin was plentiful.

But when the Japs took Malaya, things changed in a hurry. Tin became a critical material. Vast quantities of tinplate were needed to preserve food for our armed forces. A method had to be found that would not only save tin, but greatly speed production.

Steel engineers developed a way to electroplate steel strip with a coating of tin only *thirty-millionths* of an inch thick—a method which would save two-thirds of our war-scarce tin. But the problem was to "reflow" the granular, dull-gray coating deposited by electrolysis so it would be perfectly smooth and corrosion-resistant—and do it at speeds that would permit greatly increased production.

Westinghouse engineers were called in. Working closely with steel engineers, they developed a method of high-frequency induction heating with electronic control. Within 7/10 of a second after strip enters the heating coil, its fusion temperature of 450 degrees F. is attained. There is no contact between tinplate and heating coil—no danger of arcing or burning. The "flowing" operation is made an integral part of the tinning line, instead of a separate operation requiring additional handling.

600 kw units are now in operation, turning out tinplate at 500 f.p.m.—as compared with 150 to 200 f.p.m. by old methods. 1200 kw units are being built that will step up delivery speeds to 1000 f.p.m.

Soon a large part of U. S. tinplate will be rolling from production lines using this method. Tons of vital tin will be saved—as a result of close co-operation between Westinghouse and steel industry engineers.

This kind of Westinghouse engineering co-operation is available to *you* at any time, in solving any problem involving electrical power. Just phone your nearest Westinghouse office. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pennsylvania. J-94544

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

WESTINGHOUSE ENGINEERING SERVICE

A nationwide corps of engineers offers you electrical and production experience gained through years of working with the steel industry.

In addition to engineering help on specific industry problems involving electrical power, these men can give you assistance on these other vitally important activities:

PRODUCT DEVELOPMENT: engineering of equipment to meet war requirements.

MAINTENANCE: help in making existing equipment serve better, last longer.

REHABILITATION: redesigning and rebuilding obsolete equipment for useful service.

MATERIAL SUBSTITUTION: adapting available replacements for critical materials.

W.E.S. is available to all branches of the steel industry. Put it to use today on your production problems.

A WORLD OF POWER!

As one of the few great names in Electric Power, it has been the province of Crocker-Wheeler to pioneer in the application of Electric Motors and Generators for many individual industries.

Today . . . as a part of the greater Joshua Hendy Iron Works . . . our enlarged productive facilities and specialized knowledge are more than ever available to all war industry.

Crocker-Wheeler Electric Manufacturing Company. Ampere N. J., Division of Joshua Hendy Iron Works.

TRADE MARK REG. U. S. PAT. OFF.

CROCKER-WHEELER

SINCE 1888

building-block simplicity..

IN ELECTRICAL CONTROL ASSEMBLY...

Installation of four Motor Control Centers mounted back to back . . . 98" high, 21" deep, for each pair. CONTROL AT CENTER OR BY PUSH BUTTON AT MACHINE STATION.

CUBICLE PLUG-IN UNITS

Right: Control Center 13½" bus bar trough, with pull boxes top and bottom and Sizes 1, 2 and 3 motor control units. (Switchboard control units are in corresponding sizes).

Trumbull Centralized Electrical Control is assembled to meet your exact load and space requirements almost as easily as you might put together building blocks or file cabinets. We have, in fact, applied the principles of mass production and standardization of interchangeable units to give industry not only the simplest and most flexible, but also the most efficient cubicle switchboard assembly yet devised.

Here's how it works. First, you arrange Trumbull prefabricated bus bar troughs to accommodate the required number of control units in the space available (back to back, flat against walls or any way you wish). Then you install standardized switching and control units in the troughs by stab connections in a matter of minutes. Finally you make your conduit connections in the ample wiring spaces at top and bottom of the troughs and lead your circuit wires to individual units through the convenient vertical raceways built into the troughs to complete the flattest, neatest, most easily get-at-able dead front switchboard or motor control center you have seen. Everything is installable, removable, inspectable FROM THE FRONT. Trough sections or individual units can be changed or added just as quickly and easily . . . a necessity in busy plants today; assurance of flexibility for tomorrow's changing needs.

CONTROL CENTER SWITCHBOARDS

Type "A" switch units, Type "AT" circuit breaker units, 30 to 600 amps. or combinations of both may be grouped in any desired assembly to centralize power and light feeder-circuit protection and control. Also, the standardization feature permits the combining of both motor control and switchboard functions in one assembly.

TRUMBULL

CONTROL CENTERS

MOTOR CONTROL CENTERS . . .

The motor Control Centers are space saving assemblies in one cabinet of Trumbull combination magnetic starter with switch or circuit breaker disconnect. Sizes 1, 2, 3 or 4 . . . 3 to 100 H.P. Regrouping or expansion at any future time is most easily accomplished. Trumbullaid Bulletin 411 on request.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY • PLAINVILLE, CONN. • A GENERAL ELECTRIC ORGANIZATION

OTHER FACTORIES AT NORWOOD (CINN.) O. — SEATTLE — SAN FRANCISCO — LOS ANGELES

SCIENTIFICALLY ENGINEERED
FOR EVERY INDUSTRIAL USE

TYCOL

FIRE

This is #2 of a series of informative messages concerning the meaning and significance of commonly used tests and terms employed to describe the characteristics of lubricating oils.

T I D E W A T E R L U B R I C A N I A

DEFINITION: That temperature at which a lubricating oil will first give off sufficient vapors to ignite when approached by a small flame or spark is termed the flash point—the lowest temperature at which when ignited, the oil continues to burn is called the fire point.

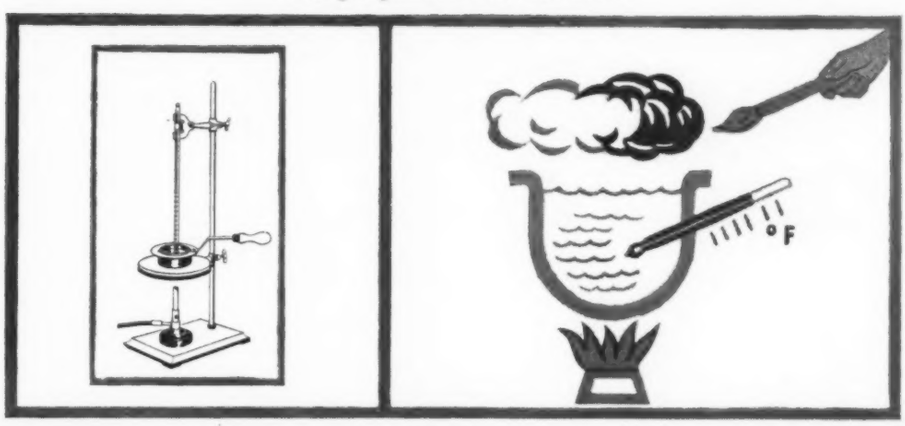
TEST: The flash point and the fire point of lubricating oil are usually determined by means of the Cleveland Open Cut Tester by following a definitely prescribed procedure. The oil under test is heated and a small pilot flame is moved over the cup with every 5°F rise in oil temperature. The first time a flash occurs on the surface of the oil, the temperature of the oil is recorded as the flash point. If the oil is heated still further and tested with the pilot flame, it will commence to burn with a continuous flame. When this occurs the oil temperature is recorded as the fire point.

For most purposes knowledge of the Flash Point alone is sufficient. It indicates the ordinary fire hazard in handling petroleum fuels and similar volatile products. With lubricating oils, Flash Points sufficiently high to avoid undue evaporation losses in service are definitely required.

The following illustrates examples of flash points of typical petroleum products, fire points being somewhat higher:

Gasoline .....below 0°F	Kerosene .....115-150°F
Cleaning Naptha ....110-115°F	Light Machine Oil....325-400°F

Heavy Cylinder Oil..525-625°F



Tycol lubricants are subject to rigid flash point control during manufacture. Uniformly correct flash points, insuring undiluted products in every grade, are one of many Tycol characteristics contributing to high quality.

TIDE WATER ASSOCIATED OIL COMPANY

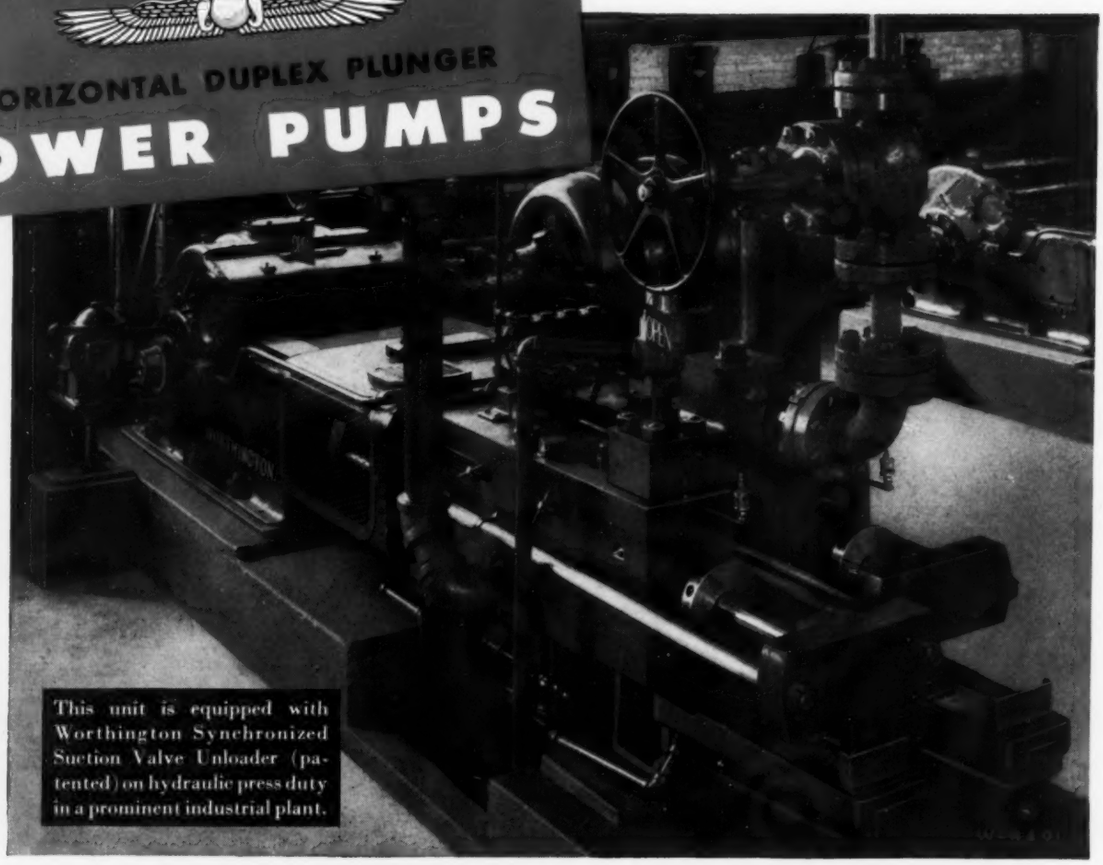
Eastern Division: 17 Battery Place, New York • *Principal Branch Offices:* Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL

INDUSTRIAL LUBRICANTS

WORTHINGTON

HORIZONTAL DUPLEX PLUNGER POWER PUMPS



This unit is equipped with Worthington Synchronized Suction Valve Unloader (patented) on hydraulic press duty in a prominent industrial plant.

Note the following important features

- Totally enclosed, self-oiling, dust-tight power end
- Roller main and pinion-shaft bearings... no adjustment is necessary
- Loads are downward toward foundation
- All parts are near floor... full accessibility
- Metal-to-metal joint on all valve hole plugs... no gaskets to leak
- Heat-treated, drop-forged stainless steel valve service
- Extra deep stuffing boxes with lantern glands for packing lubrication
- Forged-steel liquid end bored from a solid forging

Worthington duplex double-acting plunger pumps, give long life in heavy-duty service . . . with minimum care. The electrically controlled synchronized suction valve unloader with which the pump illustrated above is equipped, establishes a new standard of hydraulic pump control, accomplished efficiently on the low-pressure suction side of the pump with no shocks and negligible maintenance. Bulletins W-412-B40 and W-404-B1 describing this equipment in detail are available on request.

Both the Navy E and Army-Navy E Awards have been presented to Worthington for speed and excellence in production.

PP3-1

WORTHINGTON

WORTHINGTON PUMP & MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

Planned Production for WAR or PEACE

DETROIT STEEL CORPORATION'S
NEW ANNEALING ADDITION
FOR COILED STRIP STEEL

Planned, Engineered and Constructed by

LEE WILSON ENGINEERING

Company, Inc.

20005 WEST LAKE ROAD
Cleveland, Ohio + + + ACademy 4670

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

We're Both on the Spot

Your problem is to produce the greatest tonnage of steel you have ever been called upon to handle.

Our problem is to supply insulated wire and cable for the war effort and, at the same time, supply other vital needs within the limitations imposed upon us. Although our plants are running day and night to meet these demands, production is, at times, insufficient to meet other than war requirements.

We're both on the spot! If we occasionally fail to maintain prompt deliveries, we must all be patient! We are all devoting our energies to one objective—the winning of the war—but we must first follow instructions from those responsible for the direction of America's war effort.

Today, as always, we are interested in your cable problems and are glad to discuss them. Our Research and Engineering departments are developing new ideas daily and one that eliminates the use of vital war materials may be just the solution to a problem you have. May we suggest, therefore, that before placing an order for cable or wire, you consult our representative as to your needs, so that we may be more certain of filling your order and possibly expediting its delivery.

THE OKONITE COMPANY
Passaic, New Jersey
Offices in Principal Cities

OKONITE
Insulated Wires and Cables

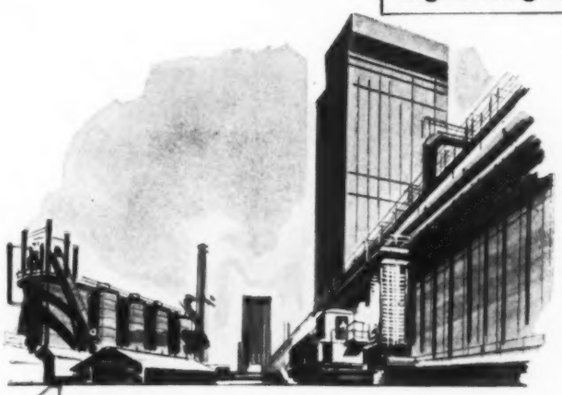
"BUY U. S. WAR BONDS—Every Payday All Okonite Employees BUY U. S. WAR BONDS"

Koppers "C & C"* Projects

*Current and Contemplated

From the "smoke of battle" to smokeless cities

Engineering and Construction Division



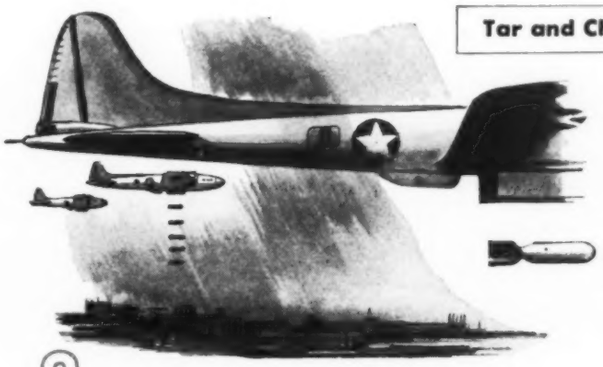
1 *Current

The new Koppers Oven plants which will produce in excess of 5,000,000 additional tons of coke per year (together with all the by-products) have been an invaluable addition to America's wartime steel industry.

2 *Contemplated

Plans for city anti-smoke ordinances are expected to produce a big new market for the added coke capacity of steel mills and gas companies when peace has removed the present desperate need for the coke in blast furnaces.

Tar and Chemical Division



3 *Current

Tar that once roofed American factories now helps "unroof" German factories. Coal derivatives which used to go into coal tar roofing pitch are now one of the sources of war-vital materials for electrodes (used in electric furnaces for the production of airplane materials).

4 *Contemplated

Wartime roofing proves anew that coal tar is best. In one war factory alone, more than 200 railroad carloads of Koppers roofing was used. On vast roofing projects like this, valuable lessons have been learned in roofing . . . and the best advice still is: "Stick to coal tar."

Koppers Company and Affiliates, Pittsburgh, Pa.

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

HERE'S THE NEWEST FURNACE CONTROL..

"Regulex" EXCITER

☛ Produces electrode speeds proportional to deviation of controlled quantity from desired value, compensates rapidly for sudden current fluctuations—yet control is stable.

☛ No large resistance in circuit—maximum rated speed of electrode motors is available for automatic correction after a "cave-in". Electrode burning is minimized.

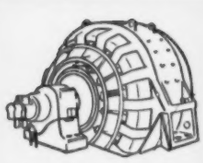
☛ Heavy starting surges, caused by throwing the 250 volt d-c motor across-the-line are done away with by variable voltage control. Also, torque is applied gradually to the electrode rope system, reducing effect of rope stretch to minimum.

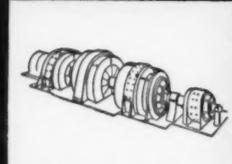
☛ Arc furnace power and control are independent of d-c shop supply interruptions when desired — fewer furnace shutdowns means increased production.

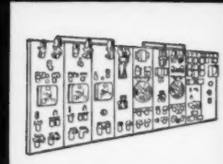
☛ Regenerative braking action of the "Regulex" exciter unit stops electrode motors fast.

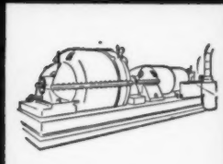
☛ Uses no contacts or motor line contactors. Maintenance is slashed.

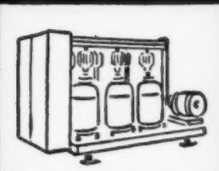
Get "All Out" production with **ALLIS-CHALMERS**


Main Drive Motors


Motor Generator Sets

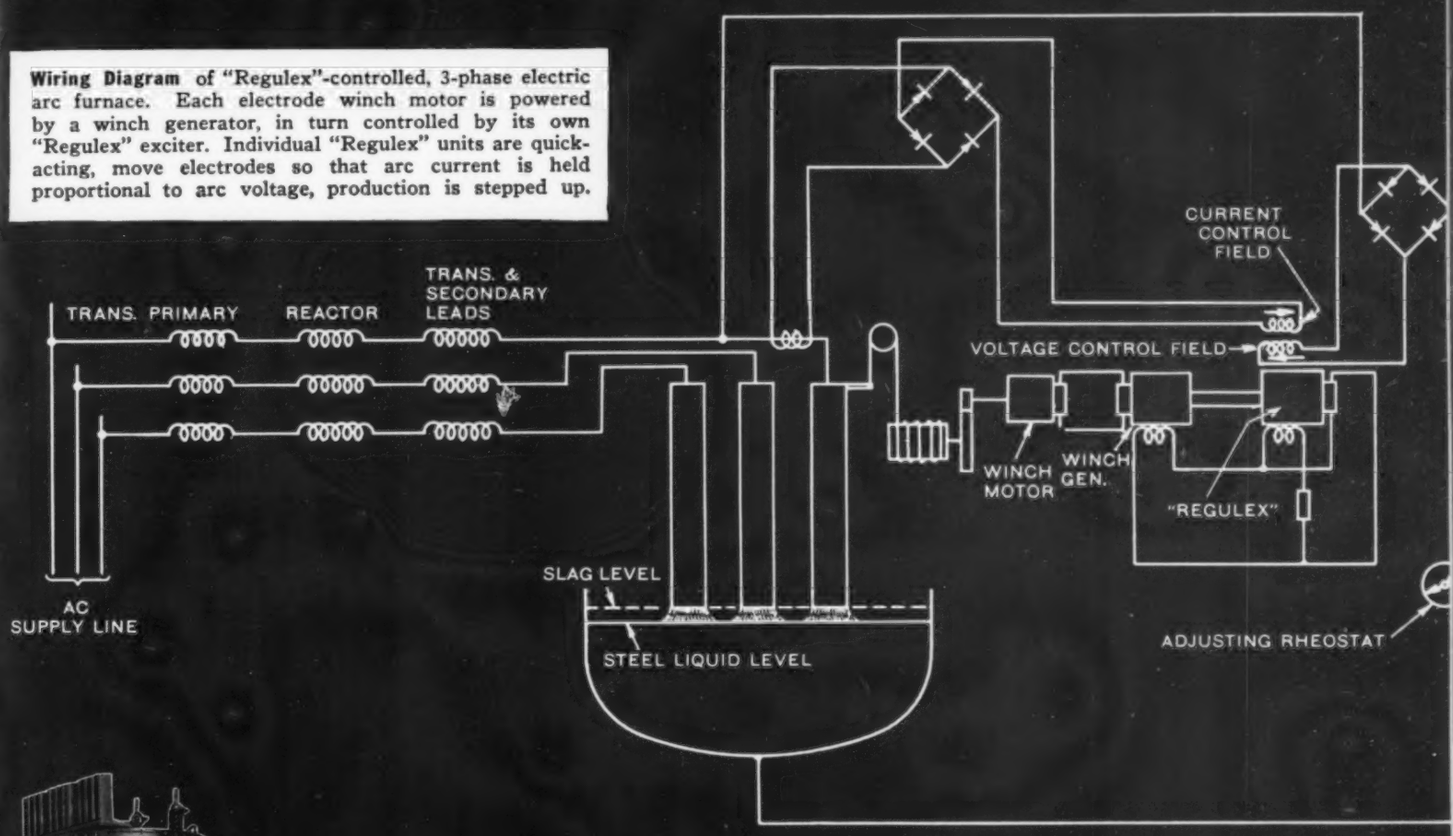

Switchboards & Control


Blast Furnace Blowers


Mercury Arc Rectifiers

THING IN ELECTRIC

Wiring Diagram of "Regulex"-controlled, 3-phase electric arc furnace. Each electrode winch motor is powered by a winch generator, in turn controlled by its own "Regulex" exciter. Individual "Regulex" units are quick-acting, move electrodes so that arc current is held proportional to arc voltage, production is stepped up.



This 3,000 kva indoor furnace transformer is part of the complete line of electric arc furnace auxiliaries designed and built by Allis-Chalmers.

NOW YOU CAN INCREASE PRODUCTION, CUT COSTS!

THE newest thing in electric arc furnace control—Allis-Chalmers revolutionary "Regulex" exciter—is bringing increased production wherever it's installed—thanks to its engineering advances that give you improved operation.

In one plant this smooth, fast-acting amplifying generator actually permitted ***one extra "heat" per day!*** This output was achieved on a furnace side-by-side with two identical units equipped with conventional control.

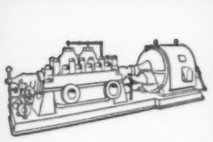
So pleased were the operators of one "Regulex" exciter-controlled furnace after only a short period of operation that they ordered eight more complete units for their other plants.

Remember, Allis-Chalmers makes a complete line of furnace electrical equipment—transformers, motors, generators, circuit breakers and control panels. Undivided responsibility pays a dividend because there's no "buck-passing."

If you've had trouble keeping your furnace power supply stable, or if you've been replacing electrodes too often, you'll find it profitable to find out about the new Allis-Chalmers control built around the "Regulex" exciter.

For complete information, call the district office near you . . . today. Or write direct to ALLIS-CHALMERS MANUFACTURING COMPANY, MILWAUKEE, WISCONSIN. A-1573

COOPERATIVE ENGINEERING



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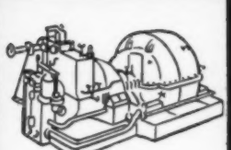

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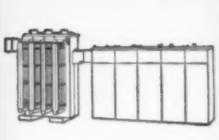

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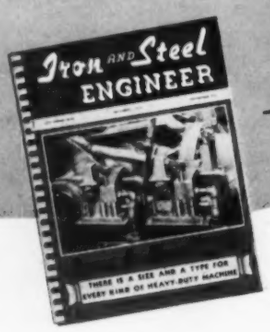

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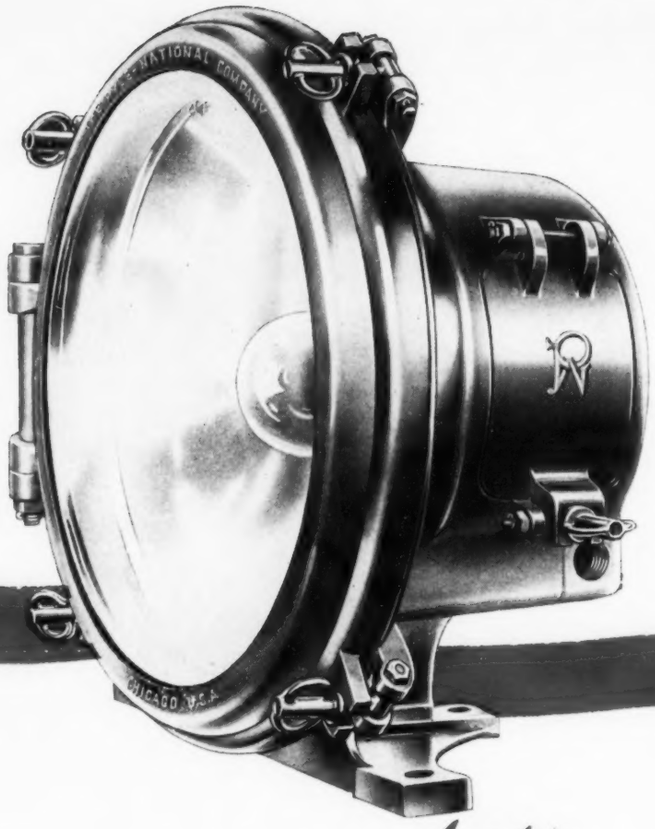

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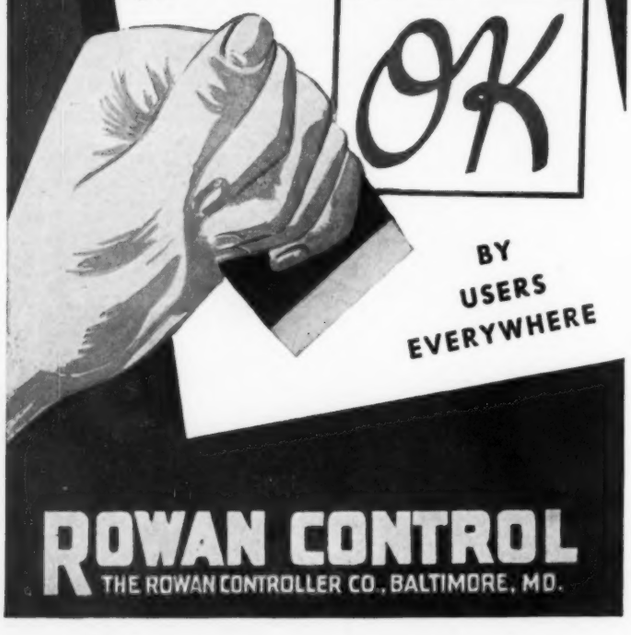

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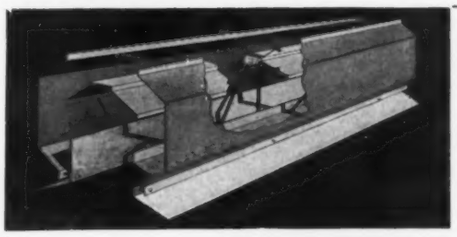

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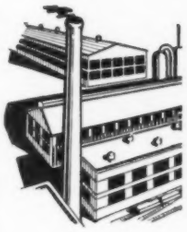

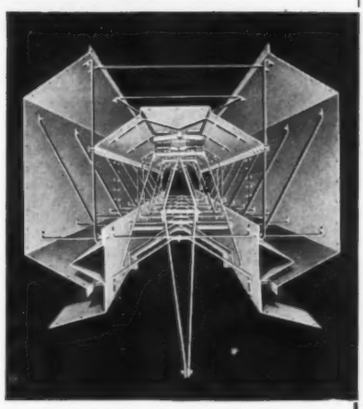

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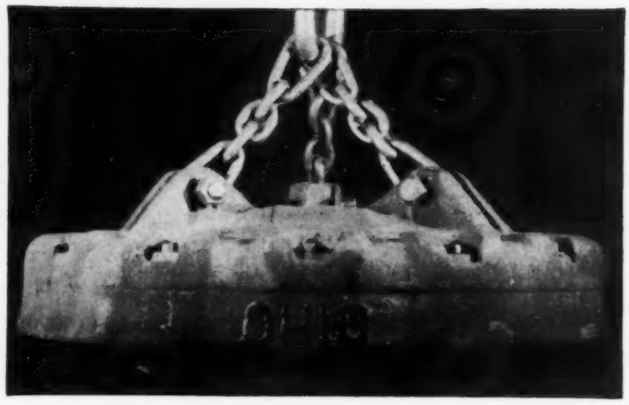

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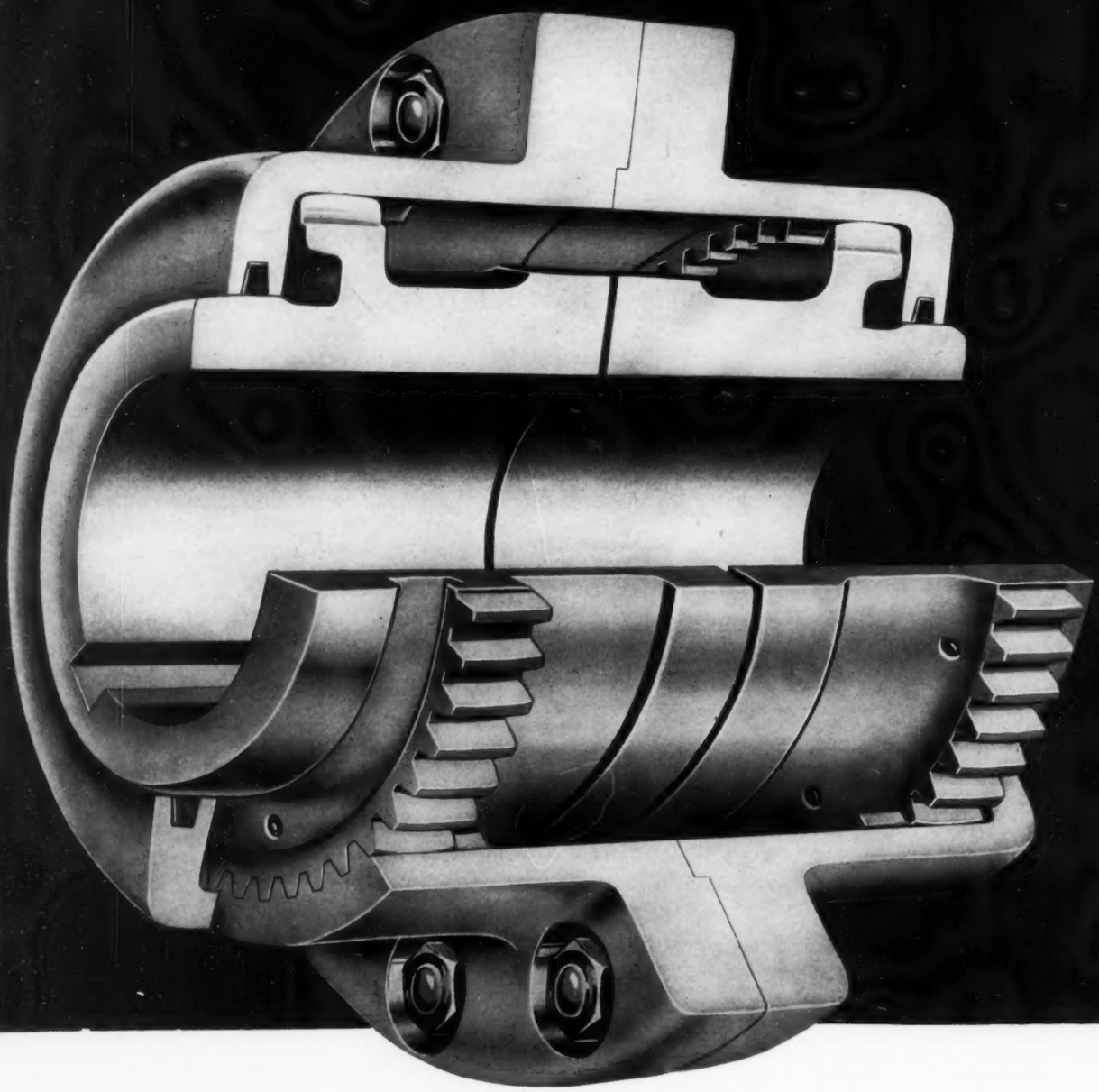

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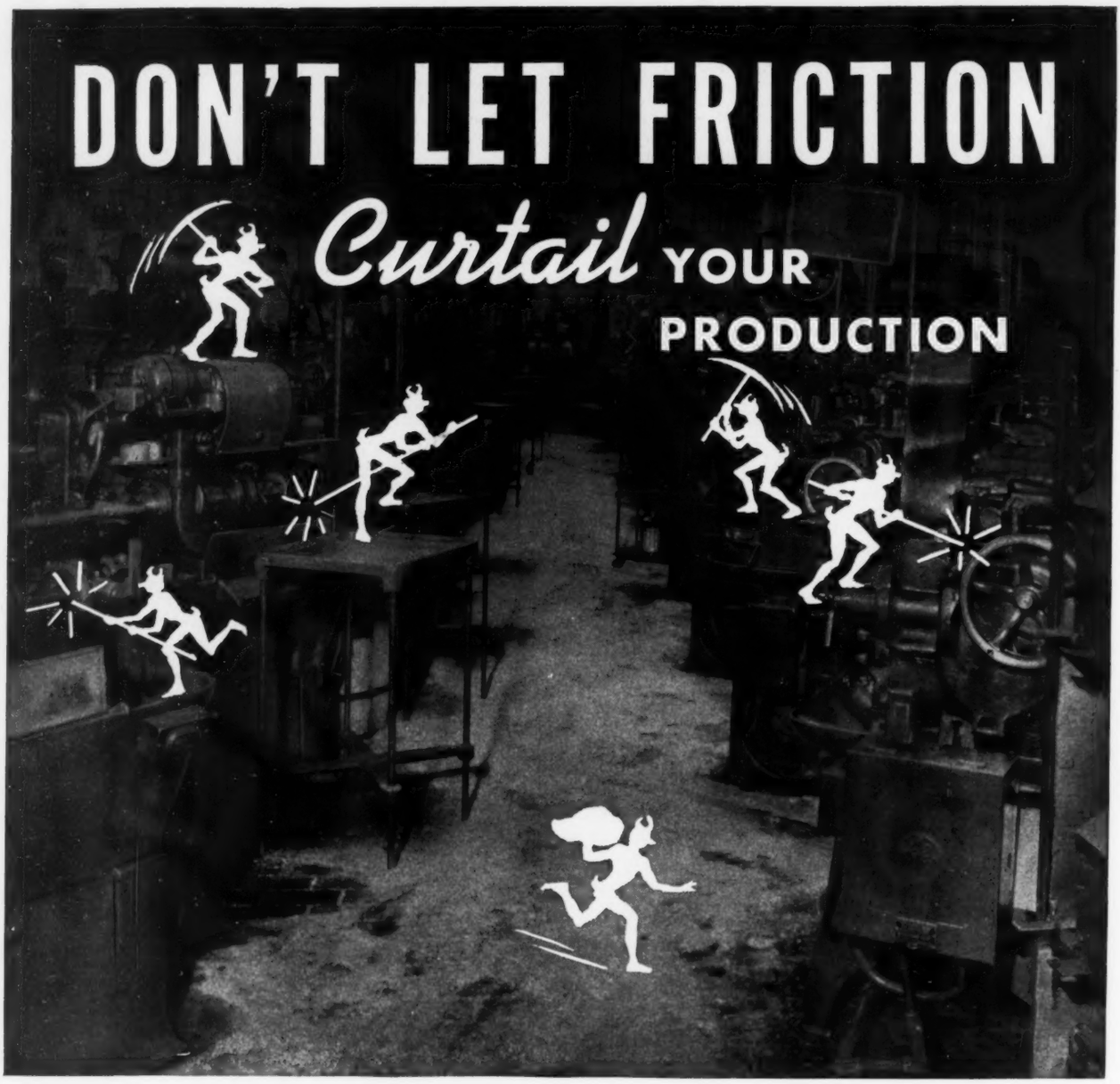

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SAVE MATERIALS AND MACHINES

On d-c motor drives and M-G sets connected in parallel...

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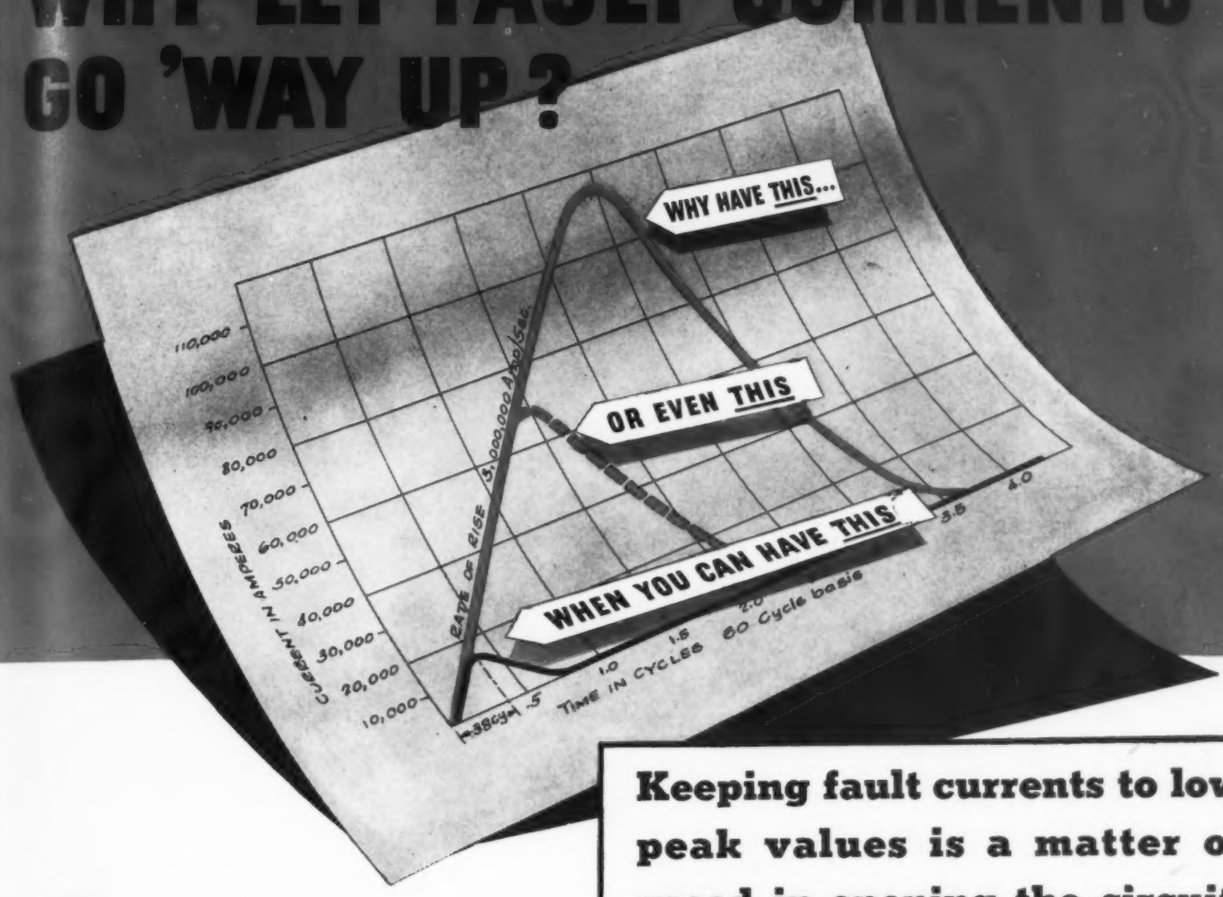

Keeping fault currents to low peak values is a matter of speed in opening the circuit.

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SAVE MATERIALS

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I-T-E has high-speed circuit breakers in service. They are new but their record is well-founded. Our engineers will gladly tell you about them.

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Name your hazard— this family can meet it

No single enclosed or explosion-proof motor is recommended for all types of hazardous service. General Electric has pioneered in producing a family of motors to meet the dangers of specific gases, vapors, liquids, and dusts. For some hazards, only G-E motors are listed by Underwriters' Laboratories, Inc. Our engineering staff can help you pick the *right* motor, control, and other auxiliary equipment for uninterrupted war production.

New totally enclosed motors that meet Class II, Group F, combustible-dust hazards

As a part of its full line of motors for hazardous locations, General Electric can now supply motors specifically listed by the Underwriters' Laboratories to meet the dangers of combustible dusts included in Class II, Group F, of the National Electrical Code. Polyphase induction motors of this construction are available from 1 to 75 hp, single-phase types to 10 hp, direct-current types to 30 hp. Vertical motors and gear-motors are also included.

Dust-tight joints, including accurately rabbeted end-shield fits, plus a labyrinth seal and close-clearance bearing lips along the shaft, exclude dust from winding and bearings. External operating temperature at permissible overloads is well below the ignition point of the specified dusts. A one-piece, nonsparking fan (for fan-cooled sizes) assures effective cooling. Easy lubrication and servicing features are part of the well-planned design. For complete details, call or write your local G-E office. *General Electric Co., Schenectady, N. Y.*

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